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RELATIVE SUCCESS IN THE N. A. I. T. THREE YEAR ELECTRONIC PROGRAM
A LONGITUDINAL PREDICTION STUDY

by

Ⓒ ALBERT N. WURFEL

A THESIS
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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance this thesis entitled "Relative Success in the N.A.I.T. Three Year Electronics Program: A Longitudinal Prediction Study" submitted by Albert N. Wurfel in partial fullfillment of the requirements for the degree of Master of Education.

ABSTRACT

The purpose of this study was to obtain information for the prediction of relative success in the N.A.I.T. three year Electronics program, to provide some descriptive statistics as to the nature of the students who entered the program in 1965 and 1966 with respect to some aptitude and intelligence measures, grade nine and high school academic achievement, and to provide some information as to the stability of relative performance over the length of the program.

The samples included all those students who entered the three year Electronics program in 1965 and in 1966, who did not withdraw for reasons other than poor achievement, and for whom complete predictor data was available. An attempt was made to develop predictor combinations for the total group including Alberta non-adult students, adult students and students from outside Alberta, on the basis of D.A.T. scores. An attempt was also made to develop predictor combinations for Alberta non-adult students on the basis of grades 9, 10 and 11 scores and on the basis of D.A.T. scores.

The criterion scores were T scores based on rank in class. Rank in class was determined on the basis of weighted average in each of the three years of the program, and for students who did not complete the year under consideration, on the basis of length of time in the program. Students who withdrew during the same quarter of studies were ranked according to weighted average in their last complete quarter.

Means, standard deviations and ranges of predictor variables were determined and tabulated. Zero order correlations between all variables were determined and tabulated. A stepwise multiple linear regression

procedure was used to determine regression equations on the basis of the data from the samples which entered the program in 1965. The regression equations were cross validated on the data from the samples which entered the program in 1966.

For Alberta non-adult students, a number of variables were found to be consistently significant predictors of relative success to the ends of each of the three years of the N.A.I.T. Electronics program for each of two independent samples. These predictors were high school Math-Science average, a regression combination of high school Science average and D.A.T. Numerical Ability, and high school academic average. High school Math-Science average was selected as the optimum predictor of relative success over the length of the program and expectancy tables were constructed based on that predictor. No consistently significant predictors were found for samples which included adult and non-Alberta students.

The Alberta non-adult students were found to be concentrated in the middle range of high school academic achievement.

The samples were found to have high correlations between relative success scores to the ends of each of the three years of the Electronics program, with the samples including adult or non Alberta students having higher criterion intercorrelations than the sample including only Alberta non-adult students.

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CHAPTER I

THE PROBLEM IN PERSPECTIVE

I. INTRODUCTION

The problem of predicting success in post secondary programs has probably received as much attention as any other single problem in education. Reasons for the intense interest in the prediction of academic success are easily determined, for at the completion of secondary schooling, the student stands at one of the major crossroads of life. He may seek immediate employment, he may choose to go to one of a number of colleges and register in his choice from a large number of specialties, or he may choose from among a number of other post-secondary institutions which offer a myriad of programs.

The student may base his choice on the information he has at hand, on what his friends are doing, on what his parents wish him to do, or on the advice of a counselor. The possession of relevant information is a necessary pre-condition for good decision making. The prediction of academic performance cannot, at present guarantee that correct determinations can be made consistently, but the greater the degree of relevant information possessed by the student, the greater the potential for good decision making.

The importance of this decision is nowhere more aptly stated than by Bloom:

> If he chooses a course, a college, and a curriculum that fulfill his needs and challenge but do not overtax his capabilities he is liable to gain much from higher education. If he chooses a college and program with requirements far above his possibility of attainment, he will suffer the frustration and loss of time and opportunity consequent on failure . . . The matter of choice is not just the student's concern . . . colleges that accept students who fail suffer great losses in utilization of faculty and other resources.[1]

II. THE PROBLEM

Statement of the Problem

The purpose of this study was:

1. To gather information that could be used as a partial basis for predicting a student's relative success in the three year Electronics program offered at the Northern Alberta Institute of Technology (hereinafter referred to as N.A.I.T.).
2. To gather information as to the stability of relative performance of students in the N.A.I.T. three year Electronics program.
3. To gather information on the previous achievement levels and ability levels of students who enter the

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[1] Benjamin Samuel Bloom and Frank R. Peters. The Use of Academic Prediction Scales for Counselling and Selecting College Entrants. (New York: Free Press of Glenco, 1961), pp. 7-8.

three year Electronics program.

Specifically, the questions this study proposed to answer were:

1. How well do the average grades in each of the combinations listed below predict relative success[2] to the ends of each of the years of N.A.I.T. three year Electronics program?
    a) Mathematics 10 or 12 and Mathematics 20 or 22
    b) Science 10 and Science 20
    c) English 10 and English 20
    d) the mean of the above listed scores
2. How well do the scores on each of the grade IX Alberta Departmental Examinations and the mean of the scores (excepting S.C.A.T.) on the Alberta Departmental Examinations predict relative success to the end of the three years of the N.A.I.T. Electronics program?
3. How well do each of the D.A.T. subtest scores predict relative success to the ends of each of the years of the N.A.I.T. three year Electronics program?
4. How well do the best combinations of the predictors listed in questions 1 to 3, as determined by stepwise

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[2] For definition of relative success, see Page 10 of this study.

multiple linear regression, predict relative success to the ends of each of the years of the N.A.I.T. three year Electronics program?

5. What are the correlations between relative success to the ends of each of the three years of the N.A.I.T. three year Electronics program, for those students who complete the three years of the program?

Hypotheses

Hypothesis 1

There is no significant correlation between the average grades in each of: Mathematics 10 or 12 and Mathematics 20 or 22, Science 10 and Science 20, English 10 and English 20, Social Studies 10 and Social Studies 20, the mean of the above listed mathematics and science grades and:

1a. relative success to the end of year A of the N.A.I.T. three year Electronics program.

1b. relative success to the end of year B of the N.A.I.T. three year Electronics program.

1c. relative success to the end of year C of the N.A.I.T. three year Electronics program.

Hypothesis 2

There is no significant correlation between grades in each of: Reading IX, Literature IX, Language IX, Social Studies IX, Mathematics IX, Science IX, S.C.A.T. Total, S.C.A.T. Verbal,

S.C.A.T. Quantitative, and:

2a. relative success to the end of year A of the N.A.I.T. three year Electronics program.

2b. relative success to the end of year B of the N.A.I.T. three year Electronics program.

2c. relative success to the end of year C of the N.A.I.T. three year Electronics program.

Hypothesis 3

There is no significant correlation between the mean of grades in Reading IX, Literature IX, Language IX, Science IX, Mathematics IX, Social Studies IX, the mean of all the high school grades listed in hypothesis 1, and;

3a. relative success to the end of year A of the N.A.I.T. three year Electronics program.

3b. relative success to the end of year B of the N.A.I.T. three year Electronics program.

3c. relative success to the end of year C of the N.A.I.T. three year Electronics program.

Hypothesis 1 to 3 were tested for significance at the .05 level of confidence for samples[3] 3 and 4.

Hypothesis 4

There is no significant correlation between the scores in each of the D.A.T. subtests; Verbal, Numerical Ability, Abstract Reasoning, Clerical Speed and Accuracy, Spatial Relations, Mechanical Reasoning, Language Usage - Spelling, Language Usage - Sentences, Verbal Reasoning and Numerical Ability and each of:

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[3] For definition of samples see pages 12 and 13 of this study.

4a. relative success to the end of year A of the N.A.I.T. three year Electronics program.

4b. relative success to the end of year B of the N.A.I.T. three year Electronics program.

4c. relative success to the end of year C of the N.A.I.T. three year Electronics program.

Hypothesis 5

There is no significant correlation between:

5a. relative success to the end of year A of the N.A.I.T. three year Electronics program and relative success to the end of year B of the N.A.I.T. three year Electronics program.

5b. relative success to the end of year A of the N.A.I.T. three year Electronics program and relative success to the end of year C of the N.A.I.T. three year Electronics program.

5c. relative success to the end of year B of the N.A.I.T. three year Electronics program and relative success to the end of year C of the N.A.I.T. three year Electronics program.

Hypothesis 5 was tested for significance at the .05 level of confidence for each of samples 1, 2, 3 and 4, and for each of groups[4] 1a, 2a, 3a and 4a.

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[4] For definition of groups 1a - 4a see page 13 of this study.

III. SIGNIFICANCE OF THE STUDY

This study provides cross-validated estimates of the validity of grades in selected secondary school subjects and aptitude tests as predictors of relative success in the N.A.I.T. three year Electronics program. It has been shown that grades in secondary school are effective predictors of success in the freshman year of college. However, very little work has been done to date regarding the predictive validity of high school grades for technology programs. This report rectifies this omission and provides information on consistency of performance over the length of the program, an area which Lavin[5] points up as one requiring further study.

Descriptive statistics with respect to the ability scores and the nature of secondary school performance of students who enter the program are also provided by this study.

For the purposes of prediction of success over the length of the program this study takes into account data for those students who dropped out as well as for those who completed the program.

IV. SETTING FOR THE STUDY

The Northern Alberta Institute of Technology has been offering trade and para-professional training to an ever increasing number of Alberta's youth since operations began in 1962. Total enrollment in

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[5] David E. Lavin. The Prediction of Academic Performance: A Theoretical Analysis and Review of Research. (New York: Russell Sage Foundation, 1965), p. 46.

the 1968-69 term was of the order of 10,000 full time students.

The present study was concerned with the three year Electronics program offered at the institution. The requirements for entry into the program in 1965 and 1966 were 67 high school credits and a B or better in Mathematics 20 or 22. Many of the students enter the program with credit in grade XII courses. However, those with a high school diploma and a B or better standing in Mathematics 30 or 32 and Physics 30 or 32 could enter a two year electronics program, rather than the three year program. A two-year program in electronics is also available for those who have completed a high school vocational program in electronics.

The three year program consists of three eight-month sessions, years A, B, and C in that order. Each year is broken down into three quarters, such that the total program consists of nine quarters each of which includes five to eight courses. Year A technology is a common year for students who wish to go into the Electronics program in year B, and for those who wish to go into the Materials Technology or Exploration Technology programs in year B.

There is no 'hard-and-fast' rule regarding the number of courses a student may fail before being asked to repeat a quarter. If a student obtains a final mark of less than 50% in more than one course in a quarter, or a weighted average of less than 50%, his performance is reviewed and he may be required to withdraw or repeat a quarter.

V. CONTEXT OF THE STUDY

This study is part of PROJECT NAIT under the direction of Dr. D. W. R. Wilson of the Faculty of Education, University of Alberta. Under investigation in this project are the structures of selected courses in the N.A.I.T. Electronics program, their relationships to secondary school academic disciplines and ability factors, and the way in which these courses may be organized in a manner most consistent with the structure of the disciplines involved.

VI. LIMITATIONS OF THE STUDY

1. Some of the students who entered the program in 1965 and in 1966 were not included in the sample because of lack of complete predictor data for them. For example, some students were absent when the D.A.T. tests were written.
2. The fact that some students who drop out return later to complete the program was not taken into account.
3. Students who dropped out of the program for reasons other than poor achievement, as defined in this study, were not considered.
4. No attempt was made to consider factors other than the predictors and criteria listed in the design of this study.
5. The reliability of grade 10 and 11 marks, and marks in

courses of the Electronics program, was not known.

6. The effect of different instructors or course changes was not considered.
7. Form B of the D.A.T. was administered in February, 1966, to the students who entered the program in 1965, while form L of the D.A.T. was administered in November, 1966 to those who entered the program in 1966. Though the two D.A.T. forms[6] correlate quite highly, they are hot identical.

VII. DEFINITIONS OF TERMS

Relative Success

Relative success shall be defined as a T score calculated on the basis of percentile rank in class. Rank in class during a given year was determined on the basis of final grades in courses taken during that year of the program for students who did not drop out of the program before the end of that year. Students who did not complete the year were ranked in order, below those who did, on the basis of the number of quarters of work they completed and on the basis of their weighted average in their last quarter in the program.

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[6] Bennett, George K., Seashore, Harold G., and Wessman, Alexander G. Differential Aptitude Tests, Manual, 4th Ed., The Psychological Corporation, New York: 1966.

For example, when considering relative success to the end of year B (six quarters), all students who completed five quarters of work were ranked in order, below those who completed six quarters on the basis of their weighted averages in the fifth quarter, while those who completed four quarters were ranked below them, etc.

The above definition of relative success is based on the assumptions listed below.

1. All students who completed any part of the program have achieved some measure of success in it.

2. The earlier a student dropped out with poor achievement, the less successful he was in the program.

3. A student who obtained a certain weighted average in a given year or a given quarter of the program had achieved a larger measure of success to that point in the program than a student who had obtained a lower weighted average in that year or quarter of the program.

4. The intervals between relative success ranks are equal in magnitude.

Weighted Average

The weighted average is the sum of the products of the final marks and the hours of instruction in courses taken in a given year, divided by the total hours of instruction in that year. The weighted average is the score used by N.A.I.T. for ranking students in a given program.

Drop-Out with Poor Achievement

A drop-out with poor achievement shall be defined as a student who dropped out of the program and received a final grade of less than 50% in at least one course in his last quarter, or whose weighted average in his last quarter was less than 55 percent.

Population

The population shall be defined as those students who meet the admission requirements for the N.A.I.T. three year Electronics program and who have applied or will apply for admission to the program in the period 1965 -- 1970.

Alberta Non-Adult Student

Alberta non-adult students shall be defined as those members of the population who received their high school training in Alberta and who had written their Grade IX Departmentals less than six years before entering the Electronics program.

Sample 1

Sample 1 shall be defined as those members of Sample 3 who were Alberta non-adult students.

Sample 2

Sample 2 shall be defined as those members of Sample 4 who were Alberta non-adult students.

Sample 3

Sample 3 shall be defined as those members of the population who registered in Year A of the N.A.I.T. three year Electronics

program in September, 1965 and for whom the following conditions were met:

1. those for whom complete predictor data was available.
2. those who either completed the program or were drop-outs with poor achievement.
3. those who were not repeating a year of the program.
4. those who remained in the program until February of Year A.[7]
5. those for whom achievement data for the Electronics program was available at N.A.I.T.

Sample 4

Sample 4 shall be defined as those students who registered in Year A of the three year Electronics program at N.A.I.T. in September, 1966 and for whom the five conditions listed for Sample 3 were met.

Groups 1a, 2a, 3a and 4a

Groups 1a, 2a, 3a and 4a shall be defined as those members of Sample 1, Sample 2, Sample 3 and Sample 4 respectively, who remained in the Electronics program over its three year length.

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[7] D.A.T. tests were written in February, 1966 by those students who entered the program in September, 1965.

CHAPTER II

REVIEW OF THE LITERATURE

This study is concerned with the prediction of success over the three year length of a technology program.

The literature review is divided into three sections. First, a review is presented of some pertinent literature related to prediction problems in general. The second section consists of a review of the literature related to the prediction of success in technical and vocational programs. Because the major portion of literature on prediction is related to prediction of college success, especially freshman success, the third section provides a review of some literature related to the prediction of school and college success.

1. LITERATURE RELATED TO PREDICTION OF ACADEMIC PERFORMANCE IN GENERAL

Bloom and Peters suggest that the sources of variation in academic performance are: errors in judgment of teachers about the quality of a student's achievement, the difference among students in achievement and motivation, and the difference in standards from school to school. They suggest that the errors in judgment of teachers have been grossly overestimated and that grade averages may have a high reliability if appropriate scaling procedures are applied to remove

the error from the other sources of variation.[1]

In a study begun in 1956, Bloom and Peters used the records of some 25,000 students who graduated from the 126 participating schools of the National Registration Office. They obtained correlations between high school achievement, aptitude test scores, achievement test scores, and college achievement. Some of their pertinent findings are as follows:

1. Average correlation between school and college grades is about + 0.50.[2]

2. Median correlations between grade averages in adjacent college semesters is + .79, median correlation between grade averages two semesters apart is + .72, and median correlation between grades three semesters apart is +.66.[3]

3. Within a school or college, academic grades and aptitude scores correlate in the order of +.50.[4]

4. The vast majority of correlations used for prediction of professional or graduate schools lie between + 0.30 and + 0.60.[5]

5. When aptitude scores and high school grades are combined by a regression method and the scores are scaled to make them equivalent for different schools and colleges, the prediction of academic success

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[1] Benjamin Samuel Bloom and Frank R. Peters, The Use of Academic Prediction Scales for Counselling and Selecting College Entrants. (New York: Free Press of Glenco, 1961). pp. V-VI

[2] Ibid., p. 37

[3] Ibid., p. 38

[4] Ibid., p. 159

[5] Ibid., p. 31

can be improved to a correlation of about 0.75.[6]

Reliability of first year college grades is estimated to be in the order of + 0.80, which represents the upper limit of prediction correlations unless the reliability of college grades is improved.[7]

Assessment techniques, which take into account sociological and psychological factors, could be useful for prediction purposes. However, large scale applications have not yet been developed.[8]

Lavin[9] reviewed some 300 prediction studies published between 1958 and 1961. A summary of some of his conclusions pertinent to this study is as follows.

Measures of ability account for 35 to 45 percent of the variation in academic performance in high school and college.[10]

A large proportion of the variance in academic achievement could be accounted for by nonintellective factors such as personality factors, sociological factors, and the interactions between them.[11]

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[6] _Ibid._, p. 151.

[7] _Ibid._, p. 131.

[8] _Ibid._, p. 30.

[9] David E. Lavin. _The Prediction of Adacemic Performance: A Theoretical Analysis and a Review of Research_, (New York: Russell Sage Foundation, 1965.)

[10] _Ibid._, p. 59

[11] _Ibid._, p. 166.

The state of knowledge with regard to socioenvironmental and psychological factors is definitely not at a sufficiently definitive level to be used for decision making in counselling, and Lavin expresses some doubt as to whether or not the same is true for intellective factors.[12]

Studies of academic performance are almost exclusively static rather than longitudinal, in design (that is, they employ criterion measures taken at only one point in time). We are therefore relatively ignorant with respect to consistency of performance and the stability of predictions over time.[13]

Martin[14] used a survey technique and a multivariate analysis procedure to identify sociological factors which influenced the amount of education an individual had obtained. Among the significant social determinants Martin identified were: the gross disposable income of the family, the number of siblings, the occupation of the father, religion of the family, and a personality measure of the father's need for achievement and his attitude toward hard work and luck.[15]

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[12] Ibid., p. 12.

[13] Ibid., p. 46

[14] David Martin, et al., Educational Achievement, It's Causes and Effects. A Report prepared by the Survey Research Center in co-operation with the U.S. Department of Health, Education and Welfare, Office of Education, Ann Arbor: 1961, Monograph No. 23.

[15] Ibid., p. 2.

Martin concluded that parental characteristics have a powerful impact on the amount of education an individual acquires. The amount of education the father has is the single most powerful social determinant, while the amount of education the mother and the paternal grandfather have are also important.[16]

Martin claimed to be able to explain 28 to 41 percent of the variation in the total amount of education individuals acquired, on the basis of an analysis of his selected sociological determinants.[17]

This sort of information is no doubt highly valuable for long term predictions for groups as a whole. However, one tends to question the value of the data for counselling an individual with regard to his chances for success in a given program. It seems doubtful that our society would accept the legitimacy of an individual's being counselled into or out of a program on the basis of a prediction battery which includes such factors as his religion or the amount of education his father has.

By the early 1950's, the use of combinations of predictors to form a prediction battery by means of regression procedures was quite common. Brogden, carried out a study to show that:

> The use of differential predictors will provide substantial increase in selective efficiency over that obtained with a single predictor.[18]

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[16] _Ibid._

[17] _Ibid._, p. 5

[18] Hubert E. Brogden, "Increased Efficiency Resulting from Replacement of a Single Predictor with Several Differential Predictors," _Educational and Psychological Measurement_, Vol. 67, No. 3, p. 185.

Bae hypothesized that a combination of predictors which would maximize prediction of high school chemistry scores could be selected by means of multiple linear regression procedures, from among 15 selected subtests of the D.A.T., Iowa Chemistry Aptitude Tests, and Science Aptitude Tests. She found that the combination of all 15 predictors yielded a multiple correlation (R = 0.78) which was not significantly better than that yielded by the best combination of 4 predictors as selected by a stepwise multiple linear regression procedure, (R = 0.75, N = 117). This combination of 4 predictors included the I.C.A.E., information on Science Test,the D.A.T. Verbal Reasoning Subtest, the D.A.T. Numerical Ability Subtest, and the Science Aptitude Examination, Part B; Reading in Science. Her conclusion was that the most efficient predictors for high school chemistry grades fall into three categories: general intelligence, background experience in science and mathematics, and reading comprehension, as measured by selected subtests of the D.A.T. Iowa Chemistry Aptitude Tests, and Science Aptitude Tests.[19]

Though combinations of large numbers of predictors often resulted in very high correlations, it became evident that the correlation coefficients often shrank dismally when these regression equations were applied on another similar group.

Guilford suggested that the use of large numbers of predictors

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[19] Agnes Y. Bae, "The Prediction of the Learning of Chemistry among 11th Grade Girls Through the Use of Stepwise and Doolittle Techniques," Educational and Psychological Measurement," Vol. 27, No. 4, 1967, pp. 1131-1136.

in regression equations has little value.

> As a matter of experience in education and psychological predictions, it has been a common finding that it rarely pays to bring into a multiple prediction situation more than four or five independant variables. By the time that this many are combined, they have fairly well covered what any additional one can do for us. This is partly a consequence of the fact that good human qualities tend to go together, (to be correlated) and partly that our predictive indices tend to remain in the same area of abilities, also ignoring personality factors, physical factors and external circumstances.[20]

Cureton explained the reasons for the shrinkage of multiple regression coefficients when regression equations are applied to another group, and the need for cross validation, as follows:

> The least square regression weights are the best weights to use in predicting the criterion scores of the validation sample subjects. Their use maximizes the multiple correlation in that particular sample. It does so by giving optimal weights to everything which, in that sample, will contribute to prediction. "Everything" includes, however, the sampling errors in the validation sample data. Hence the least squares process over-fits; it fits the errors as well as the systematic trends in data.
> Cross validation provides solutions to some of the resulting problems. In particular, it answers the question, "If we use the weights determined from one sample to predict criterion scores in another sample, what will be the aggregate correlations, in this second sample, between the predictor variable so weighted and the criterion?" This aggregate correlation is almost always appreciably lower than the multiple correlation in the validation sample, and it is necessarily lower than the multiple correlation in the cross validation sample.[21]

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[20] J.P. Guilford, Fundamental Statistics in Psychology and Education, (New York: McGraw Hill Book Co. Inc., 1950), pp. 426-427.

[21] Edward E. Cureton, "Approximate Linear Restraints and Best Predictor Weights," Educational and Psychological Measurement, Vol. 11, No. 1, 1951.

Mosier also stated that, if the combining weights of a predictor composite are determined on one sample, the effectiveness of the composite must be determined on another independent sample, a procedure he defines as cross-validation.[22]

Wessman and Bennett in a study on the prediction of college grades, used the three subtests of the College Qualification tests to develop a regression equation and then applied this equation to the data on another group in a different college. They found that the correlation of the regression equation with college grades in the second sample shrank to the point where it was not a significantly better predictor than the simple total of the three subtest scores. They explained the shrinkage in multiple correlation coefficient as being due to fitting for accidental characteristics of the validation group and due to the fact that the criteria in the second college may be somewhat different.[23]

It could be argued, however, that the reason the simple total of the three subtest scores worked as well in the second sample was that the three scores happened to contribute approximately equally to prediction for that group.

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[22] Charles I. Mosier, "Problems and Designs of Cross-Validation," Educational and Psychological Measurement, Vol. II, No. 1, 1951, pp. 5-11.

[23] A. E. Wessman and G. K. Bennet, "Multiple Regression vs. Simple Addition of Scores in Prediction of College Grades," Educational and Psychological Measurement, Vol. XIX, No. 2, 1959, pp. 243-6.

Wherry, in a comparison of cross-validation procedures and statistical inference listed the following as the more important assumptions needed for statistical inference to be drawn.

1. We start from a random sample of a specified population.
2. We are going to predict in other such random samples to be selected in the future.
3. The criterion and composite scores are both normally distributed in the population.
4. The traits selected are a random selection of all possible traits.
5. Proper correction for degrees of freedom will adequately compensate for fitting of error.[24]

Wherry states that if all these assumptions are valid, then it may be concluded that:

a) In the future random samples selected, composite R will have a mean value of shrunken R.

b) In the future random samples selected, the betas will all have the same signs as the original sample although not necessarily the same relative magnitudes.[25]

Wherry suggests that this is a meager return for a large number of assumptions. However, he expressed dissatisfaction with cross-validation on the grounds that the level of confidence is un-

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[24] Robert I. Wherry, "Comparison of Cross-Validation with Statistical Inference of Betas and Multiple R from A Single Sample," Educational and Psychological Measurement, Vol. 11, No. 1, 1951, p. 24.

[25] Ibid.

known when cross-validation is used, and suggests a procedure where statistical inference and cross-validation can be combined.[26]

However, Travers suggested that the problem of handling shrinkage by statistical methods has not been solved satisfactorily in spite of considerable study, and that when multiple correlation techniques are used, cross-validation should be carried out.[27]

II. LITERATURE PERTAINING TO PREDICTION FOR TECHNICAL AND VOCATIONAL PROGRAMS

Geiss[28] attempted to measure the relationship between high school background and success in the various technical programs offered at the Oregon Technical Institute. He reported the number of students who passed and who failed against whether or not they had taken a given high school course, or against the number of units of study they had completed in high school in a particular academic area. His sample consisted of all those students who

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[26] *Ibid.*, pp. 25-28

[27] Robert M. Travers, *An Introduction to Educational Research.* (New York: The MacMillan Co., 1964), p. 379.

[28] Almon Lewis Geiss, "An Analysis of Relationships Between Courses Taken in High School and Success in Specific Areas at the Oregon Technical Institute," Doctoral Dissertation, (Washington State University, 1966), and Ann Arbor, Mich., University Microfilms, 1966.

entered the institute in 1960, 1961 and 1962. He did a separate analysis for students who entered with a high school grade point average of 2 or better and for those who entered with a high school grade point average of less than 2.

For Electronics Technology students, Geiss reported the most significant relationship between completion of a high school physics course and success in electronics.[29] Out of 26 electronics students with a G.P.A. of 2 or better in high school, 49 (42%) failed. Out of 26 electronics students with a high school grade point average of less than 2, 19 (73%) failed.[30]

Generally for engineering technologies he found that completion of physics, chemistry and mathematics courses in high school correlated most highly with success. There were substantial differences between the success ratios of those students who entered with a high school G.P.A. of 2 or better and those who entered with a high school G.P.A. of less than 2. He also found that the number of industrial arts courses a student had in high school correlated negatively with success ratio in all technologies, and that nonacademic courses apparently do not prepare students for success at Oregon Technical Institute.[31]

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[29] Ibid., p. 96

[30] Ibid., p. 67

[31] Ibid., pp. 96-101.

Carlin studied the effectiveness of intelligence, reading, and mathematics scores as predictors of success in four vocational high schools in New York city. He found a significant difference between intelligence scores of graduates and dropouts, but did not recommend that they be used alone for counselling. He found differences in arithmetic scores of graduates and dropouts to be consistently significant and substantial, and suggested that a critical arithmetic score would be the best single predictor of success in the vocational program. He also recommended that the school board include aptitude tests in their counselling battery in the future.[32]

Checkley investigated the validities of D.A.T. scores, Lorge Thorndike intelligence scores, and the Grade XII high school average for predicting success in the N.A.I.T. Business Administration program first quarter examinations. His sample consisted of the 93 Business Administration students who entered the program in 1966 and for whom complete data was available. He found that a regression equation including 8 of the predictor variables accounted for 53% of the variance in the first quarter Business average.[33]

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[32] Francis X. Carlin, "Intelligence, Reading and Arithmetic Scores as Predictors of Success in Selected Vocational Schools." (Doctoral Dissertation, Fordham University, 1962), also Ann Arbor: University Microfilms, 1962.

[33] Stanley Meno Checkley, "The Prediction of Academic Success for Business Administration Students after First Quarter Examinations" (unpublished Institutional Study, Northern Alberta Institute of Technology, Edmonton, 1961), p. 16.

The D.A.T. numerical ability subtest accounted for 38% of the variance in Business Administration average alone, whereas that variable in combination with the Lorge Thorndike verbal and the Grade 12 average would have accounted for 46% of the total variance in first quarter Business Administration average.[34]

Price studied the use of the D.A.T. battery, and the Lorge Thorndike Intelligence tests for predicting success in first quarter Year A Technology courses and first quarter Year A Technology average at N.A.I.T. His sample included the 105 students who entered the program in 1966 and for whom complete data was available.

By the use of a stepwise multiple linear regression technique he found that a combination of D.A.T. Spatial Relations, D.A.T. Clerical Speed and Accuracy and D.A.T. Numerical Ability score predicted 34% of the variance in first quarter average.[35]

Karpoff attempted to identify the aptitude and achievement scores which would best predict success in the 22 Series Vocational courses offered at one large Alberta high school. His sample included the 646 students who completed one or more of the vocational 22 series courses at that high school in 1964, 1965 and 1966, and for whom complete data was available. The 27 predictor variables included

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[34] Ibid.

[35] Donald W. Price. "Predictive Validity of the D.A.T. Subtest Scores and the Lorge Thorndike Subtest Scores on Year A Students at N.A.I.T." (Unpublished Institutional Study, Northern Alberta Institute of Technology, Edmonton, 1967).

the grade IX Departmental Examination scores, the D.A.T. battery scores, and the Kuder Preference Record-Vocational. He set up regression equations for each of 10 courses in the vocational 22 series courses, and found that between 4 and 7 variables accounted for maximum variance in each case, which ranged from 29% to 69% of the criterion variance.[36] His regression equation for electronics 22 scores (N = 86) resulted in an R = 0.728. The equation included 4 predictor variables, the grade IX science mark, the Kuder Computational Score, D.A.T. Verbal Reasoning score, and the Verbal Scat (-).[37]

Karpoff[38] did not cross-validate his regression equations. It seems that the multiple correlation of the equation arrived at for predicting electronics scores might well shrink upon cross-validation, as it includes two verbal scores, one with a (+) beta weight and another with a (-) beta weight.

Campbell [39] investigated the predictive validity of grade IX Departmental scores at a Vocational high school in Alberta. His sample consisted of the 443 students who completed one or more of the 10 vocational courses offered by that school during the period

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[36] John Theodore Karpoff. "Aptitudes for Achievement in the Vocational Programs of One Composite High School in Alberta," (unpublished M. Ed Thesis, University of Alberta, Edmonton, 1967.)

[37] Ibid., p. 84

[38] Ibid.

[39] Theodore Roy Campbell. "Grade IX Marks as Predictor Criteria For Success in Selected Vocational Subjects," (Unpublished Master's Thesis, University of Alberta, Edmonton, 1966.)

1963 - 1966 inclusive. Grade IX subjects which had the highest zero order correlations with final grades in a vocational subject were most often Science IX, Math IX, and Q. S.C.A.T. [40] with the median highest single correlation coefficient being 0.424.[41] The average level of criterion variance explained by multiple regression equations for the individual subjects was found to be 29.24% which the investigator concluded was too low to justify their use over that of the single best predictor.[42] This is probably especially true in the case where samples were small, the extreme case being where N = 12, and the predictor equation contained 3 predictor variables.

III. REVIEW OF LITERATURE RELATED TO THE PREDICTION OF SCHOOL AND COLLEGE PERFORMANCE

The vast majority of prediction studies have been concerned with the prediction of college performance, especially the prediction of first year college performance. The following is a review of some literature related to prediction of school and college performance with a special emphasis on studies which used data beyond the first year level and those which were concerned primarily with the Alberta scene.

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[40] *Ibid.*, p. 82.

[41] *Ibid.*, p. 87.

[42] *Ibid.*, p. 76.

Scott investigated the correlations between high school grades and college performance in mathematics and science with data from the graduates of the University of Arkansas during the period 1960 - 1964. He concluded that the average achievement in all high school mathematics and science courses is an excellent predictor of freshman success in mathematics and science courses, a good predictor of sophomore success in mathematics and science, and a poor predictor of performance in junior and senior mathematics and science.[43]

A summary of his findings for overall averages is tabulated below:

TABLE I

INTERCORRELATIONS BETWEEN ACHIEVEMENT IN EACH OF THE FOUR CLASS LEVELS FOR ALL COLLEGE SCIENCE AND MATHEMATICS AT THE UNIVERSITY OF ARKANSAS.[44]

			1	2	3	4
1.	All Freshman Science & Math	r	1.000	0.634	0.481	0.312
		N	1095	953	411	264
2.	Sophomore	r		1.000	0.607	0.449
		N		953	397	264
3.	Junior	r			1.000	0.577
		N			411	259
4.	Senior	r				1.00
		N				264

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[43] Ralph Lincoln Scott, "The Relationship Between Achievement in High School and Success in College with Reference to Science and Mathematics, (Doctoral Dissertation, University of Arkansas, 1966), and (University Microfilms, Ann Arbor, 1966), p. 370

[44] Ibid., p. 314.

In the above table the low correlations between performance in the different college years are of special interest, with first year science and mathematics scores accounting for something less than 10% of the variance in fourth year science and mathematics achievement.

A major criticism of Scott's[45] study would be that he used only data from graduates. It would seem that the value of the study would be somewhat limited for counselling prospective students, as the population applying for admission to a college is quite different from the graduate population.

Lewis carried out a study to investigate the efficiency of pre-college variables for predicting grade point averages for students enrolled in the Iowa State University's College of Pharmacy in 1952, 1953 and 1954. Rank in high school class, high school G.P.A., the number of high school physical science units completed, and the percentile mathematics scores of the College Entrance Tests were used as predictors.

He found the multiple correlation coefficient between predictors and freshman G.P.A. to be 0.6. However, the validity of these predictors fell markedly as predictors of sophomore and junior achievement, and he used freshman G.P.A. and sophomore G.P.A. in his predictor equations for junior performance, which kept multiple R at the 0.6 to 0.7 level.[46]

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[45] Ibid.

[46] John W. Lewis, "Pre-College Variables as Predictors of Freshman, Sophomore and Junior Achievement," Educational and Psychological Measurement, Vol. 24, No. 2, 1964, pp. 353-356.

The fact that Lewis' prediction equations included the freshman and sophomore G.P.A. to predict success in the junior year would render them of little value for counselling the prospective pharmacy student as this information would not be available at the time the decision to enter the program would be made.

Wood and Lebold[47] carried out one of the few cross-validated studies encountered in their development of equations for prediction of freshman success in engineering at Purdue University. The sample consisted of the 616 engineering freshman who were enrolled in an engineering graphics course in 1966. 106 of the students were randomly selected from the sample as a cross-validation sample. Predictors used were high school rank in class and scores on the following tests: D.A.T. Clerical Speed and Accuracy, Spatial Relations, Mechanical Reasoning, Abstract Reasoning, S.A.T. Verbal and S.A.T. Mathematics.

High school rank, D.A.T. Spatial Relations and S.A.T. Mathematics were found to be optimal predictors, with D.A.T. Mechanical Reasoning also valuable in prediction of graphics grades.[48] Multiple R's ranged from 0.58 to 0.38, and cross-validation correlations ranged from 0.50 to 0.32.[49]

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[47] Donald A. Wood and William K. Lebold, "Differential and Overall Prediction of Academic Success in Engineering," Educational and Psychological Measurement. Vol. 28, No. 4, 1968, pp. 1223-1228.

[48] Ibid., p. 1226

[49] Ibid.,

Black carried out a series of studies related to the prediction of freshman success at the University of Alberta. In a study to determine the validities of grade IX Departmental grades for predicting freshman success, Black[50] used the data from 529 students who entered the University of Alberta in 1956. Black reported a multiple correlation coefficient of 0.408 between freshman university average and a predictor combination which included the scores in grade IX math, science, social studies, and reading grades, in that order of weight. Black concluded that it is possible to predict success in related university freshman courses on the basis of grade IX results with a sufficient degree of accuracy that such prediction would be of real value in the guidance program.[51]

It must be remembered, however, that the sample was a very select group of grade IX students, with a mean grade IX average between 75 and 80%.

In another study with the data on the same group of 529 students, Black investigated the validity of grade XII Departmental marks, grade IX departmental marks, S.C.A.T. scores, A.C.E. subtest scores, C.E.E.B. scores and S.A.T. scores for the prediction of freshman success.[52]

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[50] Donald B. Black, "The Prediction of University Freshman Success Using Grade IX Departmental Scores", Alberta Journal of Educational Research, Vol. 5, No. 4, 1959, pp. 229 - 239.

[51] *Ibid.*, p. 234

[52] Donald B. Black, "Prediction of Freshman Success in the University of Alberta from Grade XII Departmental Results," Alberta Journal of Educational Research, Vol. 6, No. 1, 1960, pp. 38-53.

He found the grade XII science average to have the largest zero order correlation with university average ($r = 0.632$), and a regression equation which combined the grade XII Departmental grades in English, Science average, Math average, Foreign Language and Social Studies, was deemed to be the best operational combination for all university courses studied.[53] Multiple correlations reported with this combination of predictors was + 0.656 for the whole group and 0.670 for that part of the group in engineering.[54]

In a follow-up study Black's regression equations were applied six years later to another sample of students entering engineering. The prediction equation was not found to shrink significantly.[55]

Knowles and Black studied the use of the Principals' Confidential Estimates of the Grade XII Departmental Examination results for prediction of freshman success, and found that the loss of predictive efficiency when principals' estimates are used in place of the actual Departmental scores was only 2.3%[56] This would seem

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[53] Ibid., p. 45.

[54] Ibid.

[55] Donald B. Black, "Validity of Regression Equations After Six Years to Predict Freshman Success in Engineering," Alberta Journal of Educational Research, Vol. 10, No. I, 1964, pp. 125-136.

[56] Donald B. Black and Donald W. Knowles, "The Effectiveness of the Grade XII Principals' Rating Scores to Predict Freshman Success at the University of Alberta," Alberta Journal of Educational Research Vol. XI, No. 2, p. 125.

to confirm Bloom's[57] contention that teachers' grades were perhaps more accurate than are commonly credited.

Fair[58] investigated the validity of the grade XII average, and scores on A.C.E. and C.O.O.P. English tests for predicting success of freshmen in Education. He found the grade XII average to be the best single predictor of freshman success in Education, and that prediction of success from the grade XII average was almost as accurate as that obtained when all six predictors were used in a regression. Fair reported a zero order correlation between freshman average and grade 12 average at $r = + 0.44$ for males ($N = 180$) and $r = 0.64$ ($N = 318$) for females.[59]

Evanson and Smith[60] reported the findings of a study wherein some of the correlates of university achievement were investigated with a sample from those who entered the University of Alberta as freshmen in 1951. Some of their findings pertinent to this study are summarized in the tables below.

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[57] Bloom, op. cit.

[58] Donald C. Fair, "Predictive Validity of the Grade Twelve Average and Scores on the American Council on Education Psychological Examination and Co-operative English Tests for Achievement in the Faculty of Education." (Research Bulletin of Student Counselling Services, University of Alberta, Edmonton), Vol. 1, No. 3, 1964, (mimeographed).

[59] Ibid., pp. 4-5

[60] A. B. Evanson and D. E. Smith, "A Study of Matriculation in Alberta," Alberta Journal of Educational Research, Vol. 4, No. 2, 1958, pp. 67 - 83.

TABLE II

COEFFICIENTS OF CORRELATION (r) BETWEEN FIRST YEAR MARKS AT UNIVERSITY AND MARKS IN LATER YEARS[61]

First Year Average with:	r	No. of Cases
Second Year University Average	0.63	51
Final Year University Average Students graduating in 3 years)	0.45	181
Final Year University Average (Students graduating in 4 years)	0.47	199

Students graduating in 4 years includes students graduating in normal time in a 4 year course, and those who took 4 years to complete a 4 year program.

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[61] *Ibid.*, p. 70

TABLE III

COEFFICIENTS OF CORRELATION (r) BETWEEN GRADE IX RESULTS AND UNIVERSITY MARKS OF 1951 FRESHMEN[62]

Correlated With:	Gr. IX Average		Gr. IX General Test	
	r	No. Cases	r	No. cases
First Year University Average	0.40	647	0.14	640
Final Year University Average (Students graduating in 3 years)	0.42	117	0.16	116
Final Year University Average (Students graduating in 4 Years)	0.25	152	0.15	151

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[62] *Ibid.*, p. 68

TABLE IV

COEFFICIENTS OF CORRELATION (r) BETWEEN GRADE XII STANDING OR A.C.E. SCORES AND UNIVERSITY MARKS OF 1951 FRESHMEN[63]

Correlated with:	Gr. XII Average		A.C.E. Score	
	r	No. Cases	r	No. Cases
First Year University Average	0.48	881	0.36	523
Second Year University Average	0.54	478	0.16	350
Final Year University Average (Students graduating in 3 Years)	0.36	170	0.15	116
Final Year University Average (Students graduating in 4 years)	0.50	191	0.18	136

The observation that the intercorrelations between achievement in the different years of university are quite low, and lower than that between the grade XII average and achievement in some cases is of particular interest in the findings of Evanson and Smith.[64] However, it must be remembered that comparisons between the correlations are somewhat risky in that different samples were used for each correlation.

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[63] Ibid., p. 69

[64] Ibid.,

IV. OBSERVATIONS FROM THE LITERATURE

1. A vast amount of prediction research has been done for estimating first year university achievement. However, very little research has been done in predicting success in the later college years.

2. Of the investigations on the predictability of success through the length of the program, almost all use data for only those who complete the course. This limits the usefulness of the information for counselling prospective students, as the selected population that succeeds must necessarily be different from population which enters the program in any situation where prediction is to be of value.

3. The high school academic average seems to be a good predictor of freshman success in university and remains reasonably stable as a predictor of success over the length of the program.

4. There appears to be a paucity of literature in the area of prediction studies for vocational and technical programs, especially as compared to the amount of literature relating to prediction of college success. Vocational and technical programs are generally more specialized and less academic than university programs. Further, the entrance requirements for vocational and technical schools are usually lower with respect to high school academic standing than are the entrance requirements of universities. This factor may well result in different student populationsin the different institutions. Hence, good predictors of success in

university programs are not necessarily valid predictors of success in technical and vocational programs.

5. The consistency of performance over the length of a program appears to be a limiting factor in the prediction of success, with the intercorrelations between achievement in the different college years often being no higher than the intercorrelations between college achievement and combinations of pre-college variables.

6. A combination of high school achievement scores and aptitude scores, as determined by multiple linear regression procedures, has often been found to predict up to 50% of the variance in freshman success.

7. Sometimes simple combinations of predictor scores, such as averages, have been found to be as efficient for prediction as regression scores.

8. Studies using multiple linear regression procedures should be cross-validated.

9. Certain subtests of the D.A.T. and S.C.A.T. have been found to be significant predictors of success in college and technical programs.

10. Teachers' marks can be as effective for prediction purposes as standardized examinations which measure high school achievement.

CHAPTER III

EXPERIMENTAL DESIGN AND PROCEDURES

The purpose of this investigation was to obtain information which could be useful for the prediction of success in the N.A.I.T. three year Electronics program, to provide some information about the stability of performance over the length of the program, and to provide some descriptive statistics regarding high school achievement and ability measures of the students entering the Electronics program.

I. THE SAMPLES

Sample 1 consisted of those students who had registered in the N.A.I.T. three year Electronics program in September, 1965 and for whom the following conditions were met:

1. those for whom complete predictor data was available.
2. those who either completed the program or were drop-outs with poor achievement.[1]
3. those who were not repeating a year of the program.
4. those who remained in the program until February of Year A.[2]

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[1] See page 12.

[2] D.A.T. was written by 1965 group in February, 1966, therefore only those from both groups who remained in the program until February of Year A were included.

5. those for whom achievement records were available at N.A.I.T.

6. those who had received their high school training in Alberta and who had written their grade IX Departmental less than 6 years before entering the Electronics program.

Sample 2 consisted of those students who entered the N.A.I.T. three year Electronics program in September, 1966, and for whom the six conditions listed for sample one were met.

Sample 3 consisted of those students who entered the N.A.I.T. three year Electronics program in September, 1966 and for whom the following conditions were met:

1. those for whom D.A.T. subtest scores were available.

2. those for whom records in Electronics were available at N.A.I.T.

3. those who remained in the program until February of Year A.

4. those who either completed the program or were drop-outs with poor achievement.

5. those who were not repeating a year of the program.

Sample 4 consisted of those students who entered the N.A.I.T. three year Electronics program in September, 1966 and for whom the 5 conditions listed for sample 3 were met.

Table V summarizes the sampling procedure and shows a number of students in each sample.

TABLE V

SAMPLE SELECTION

Classification	Sept. 1965	Sept. 1966	Sample 1	Sample 2	Sample 3	Sample 4
Total Year A Technology Registrants	143	121				
Exploration Technology	-30	-26				
Instrumentation Technology	-10	-17				
Transfer to other Technologies	-3	-0				
	-43	-43				
Total Year A Electronics	110	78				
Left program before Feb. of Year A (time of writing DAT for Sept/65 group.)	-2	-2				
In program till Feb. of Year A but did not write D.A.T.	-5	-5				
Record of technology program not available	-4	-3				
Repeat from another year, or transfer in	-6	-2				
Withdrew for reasons other than poor achievement	-7	-10				
Total useable Sample	76	56			76	56
Students who took their high school outside of Alberta	-10	-4				
Alberta non-adult students, high school records not available	-1	-0				
Adult students from Alberta	-15	-6				
Total sample, non-adult, Alberta Students	50	46	50	46		

II. DATA USED

The raw data used in this investigation consisted of:

1. the final marks in the selected Grade 10 and 11 subjects, in intervals of 5 percent, as recorded in the files of the Alberta Departmment of Education.

2. the final marks on the Grade IX Departmental Examinations as recorded in the files of the Alberta Department of Education. All marks were in percent except for S.C.A.T. scores. The S.C.A.T. total was in percentile, while the S.C.A.T. verbal and quantitative scores were in stanine form.

3. the D.A.T. subtest raw scores as recorded by Wilson[3] and in the files of the N.A.I.T. counselling department.

4. rank in class on the basis of weighted average for each year of the Electronics program, as recorded in the files of the registrar at N.A.I.T. (where rank data was not available final grades in each course, in percentage, were obtained from the same files).

The D.A.T. Battery, Form B, was administered in February, 1966 to the group which entered Year A Technology in September, 1965. The D.A.T. Battery, Form L was administered in November, 1966 to the group which entered Year A Technology in September, 1966. Administration of the tests was carried out under the supervision of the N.A.I.T. guidance department.

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[3] D.W.R. Wilson and F.H. Babet, ("Establishment of Differential Aptitude Test Norms for Electronics Technology Students," Unpublished Institutional Study, Northern Alberta Institute of Technology, Edmonton: 1966)

Until this year Grade IX Departmental Examinations were administered to the total Alberta Grade IX population each June. The tests were constructed by individuals designated by the Alberta Department of Education, and were scrutinized and modified by revisions committees appointed by the Alberta Department of Education. The tests were sent to the schools in June, and administration was carried out according to regulations and a schedule published by the Department of Education.

Tests were machine scored or marked by teams working under the direct supervision of the Department of Education. The scores were scaled on the basis of the performance of the total Alberta Grade IX population of a given year.

The S.C.A.T. test was administered as part of the Grade IX Departmental Examination Battery.

Marks in grade 10 and 11 courses were recorded in Department of Education files as received from individual schools. These marks were usually as assigned by individual subject teachers.

Marks in individual courses at N.A.I.T. are usually based partly on individual teacher ratings and partly on common examinations, though procedure varies from department to department.

III. DATA TRANSFORMATIONS

The raw data for grade 9 results was used as obtained.

The mean of the two final course marks in each of the selected grade 10 and 11 subjects[4] was calculated. Where a student

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[4] See page 47 for list of selected grade 10 and 11 subjects.

repeated a course he was assigned the average of his final grades as his mark in that course.

The D.A.T. subtest scores were converted to percentile scores on the basis of grade 12 norms provided in the D.A.T. handbook for Form B,[5] and grade 12 spring norms provided in the D.A.T. handbook for Form L.[6]

The weighted averages[7] of the N.A.I.T. grades were calculated for each year of the program. The students in each sample were then ranked in accordance with the relative success[8] model. That is, they were ranked on the basis of their weighted averages for that year. If a student dropped out before the completion of that year, he was ranked below those who completed the year, and below those who dropped out after him; he was ranked above those who dropped out before him. All students who dropped out in the same quarter were ranked according to weighted average in the final quarter.

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[5] George K. Bennett, Harold G. Seashore and Alexander G. Wesman, (Differential Aptitude Tests, Manual, Second Ed., The Psychological Corporation, New York: 1952), p. 34.

[6] George K. Bennett, Harold G. Seashore and Alexander G. Wesman, (Differential Aptitude Tests, Manual, Fourth Ed., The Psychological Corporation, New York: 1966), p. 3-20.

[7] For definition of weighted average, see page 11.

[8] For definition of Relative Success, see page 10.

The ranks were then converted to T scores, with a normal distribution, mean of 50, and standard deviation of 10.

The relative success model for criterion data was used for the following reasons:

1. it made possible the inclusion of data for those who dropped out due to poor achievement as well as those who completed the program, thereby making the sample more nearly like the total group that entered the program than would have been the case if only data from those that completed the program were included.

2. it offered some control for the fact that different forms of the D.A.T. were administered to the different samples at different points in the program.

3. it offered some control for possible differences in standards from one year to the next, a factor which was considered to be important because, at the end of Year A three year students are put in some of the same courses and classes as high school graduates who enter the two year electronics program.

The criterion scores were transformed to T scores to avoid correlating variables with rectangular distributions (ranks), with variables which were assumed to have more nearly normal distributions, and because it would facilitate application of results.

IV. PREDICTOR VARIABLES

The predictor variables used were:

A. Grade IX final grades:

XI Reading, percent
X2 Literature, percent
X3 Language, percent
X4 Social Studies, percent
X5 Mathematics, percent
X6 Science, percent
X7 S.C.A.T. total, percentile
X8 S.C.A.T. Verbal, Stanine

X9 S.C.A.T. Quantitative, Stanine

B. The means of the final grades in the two courses in each of the selected grade 10 and 11 subject areas:

X10 mean of final grades in English 10 and English 20

X11 mean of final grades in Social Studies 10 and Social Studies 20

X12 mean of final grades in Mathematics 10 or 12 and Mathematics 20 or 22

X13 mean of final grades in Science 10 and Science 20

C. The D.A.T. subtest percentile scores:

X14 Abstract Reasoning

X15 Clerical Speed and Accuracy

X16 Mechanical Reasoning

X17 Numerical Ability

X18 Spelling

X19 Sentences

X20 Spatial Relations

X21 Verbal Reasoning

X22 Verbal Reasoning plus Numerical Ability

D. The means of the grade 9 and grade 10 and 11 scores:

$X23 = (X1 + X2 + X3 + X4 + X5 + X6)/6$

$X24 = (X10 + X11 + X12 + X13)/4$

$X25 = (X12 + X13)/2$

All of the predictor variables, X1 - X25 were used for samples 1 and 2, whereas predictor variables X14 to X22 were used for samples 3 and 4.

V. CRITERION VARIABLES

The criterion variables used were T scores calculated on the basis of relative success in each sample to the end of each year of the three year program:

Y1 relative success to the end of Year A of the N.A.I.T. three year Electronics program.

Y2 relative success to the end of Year B of the N.A.I.T. three year Electronics program.

Y3 relative success to the end of Year C of the N.A.I.T. three year Electronics program.

VI. STATISTICAL ANALYSIS PROCEDURE

The data was punched onto computer cards by the staff of the Educational Research Services Division, University of Alberta.

For each sample the correlation matrix, the mean and the standard deviation of each variable, and the significance level of each zero order correlation coefficient on the basis of a T test, were calculated by means of the use of the Dest. 02 Program, an I.B.M. 360/67 program from the files of the Educational Research Services Division. Regression equations for each of the criterion variables for sample 1 and for sample 3, were calculated through the use of the Reg. 300 Program, an I.B.M. 360/67 program from the files of the Educational Research Services Division.

The Reg. 300 Program uses a stepwise multiple linear regression procedure. The regression equation using the predictor with the highest zero order correlation with the criterion variable

is determined first, the predictor which adds most to the multiple correlation coefficient is added to the regression equation in the next step, and so on. Iterations stop when further addition of variables to the regression equation does not add significantly to the multiple R. Further, if after addition of a variable to the regression equation, any one of the variables no longer adds significantly to the prediction, that variable is removed from the regression equation, in the next step. Percent of the criterion variance accounted for by the regression equation, the significance level of the regression equation and the significance level for each variable entering or leaving the equation are shown on the computer printout in addition to the regression equation. Significances are determined on the basis of an F test.

For this investigation, significance levels for variables entering or leaving the regression equation were set at the .05 level.

The regression equations determined for samples 1 and 3 at each step of the Reg. 300 procedure for each of the criterion variables were then cross-validated on the data from samples 2 and 4. The regression scores were generated and the zero order correlations and significance levels were determined by means of the Dest. 02 program. The grade 9 averages X23, the grade 10 and 11 averages X24, and the math-science average X25, were also generated and the correlation coefficients were also determined by means of the Dest. 02 program for sample 1 and for sample 2.

The best two combinations of predictors were then selected on the basis of equal weights for each of: a) the highest average zero correlation with the three criterion variables for the cross-validation group, b) the highest zero order correlation with the criterion variable Y3 of the cross-validation group and c) the number of predictors in the combination (minus).

The beta weights for the regression equations using these combinations of variables for predicting each of the three criterion variables were then calculated by means of the procedure outlined by Ferguson,[9] and the zero order correlation coefficients between each of the six regression equations and each of the three criterion variables for the validation and for the cross-validation samples were determined by means of the Dest. 02 program.

Expectancy tables were constructed on the basis of the best combinations of predictors for success to the end of Year C of the three year Electronics program.

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[9] George A. Ferguson, (Statistical Analysis in Psychology and Education, second edition, McGraw Hill Book Company, New York; 1966), pp. 392-394.

CHAPTER IV

RESULTS AND STATISTICAL TREATMENT

I. DESCRIPTIVE STATISTICS

Table VI, page 53, shows the number of students in each sample, and their distribution with respect to number graduated and time of drop out. Table VI indicates that just over half of the original total number of students graduated after three years in the program. Just under two-thirds of the group which registered in 1965 (Sample 3), graduated. Just over one-third of the group which registered in 1966 (Sample 4), graduated. The proportion of students who graduated from sample 4 might be raised, should some of those who failed at the end of the 9th quarter succeed in passing supplemental examinations which they may write in the fall of 1969.

Taking the total number of students from the samples into consideration, it was found that approximately equal proportions of Alberta non-adult students, Alberta adult students and non-Alberta students succeeded in graduating.

Table VII, page 54, indicates that the level of achievement of the students in samples 1 and 2 fell generally within the middle of the range for grade IX students in the selected subject areas and general intelligence as measured by S.C.A.T. The students as a whole scored somewhat better with respect to the math-science area than with respect to the Language areas.

Table VIII, page 55, indicates that the senior high school achievement of the groups centered around the middle of the achievement range for the total Alberta high school population.[1] None of the students had markedly superior scores or markedly inferior scores.

Table IX, page 56, indicates that there is a wide variation in aptitudes of the students as measured by the D.A.T. Some students made markedly superior scores while others made markedly inferior scores on each D.A.T. subtest, except for the N.A. Subtest where there were no markedly inferior scores.

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[1] Alberta Department of Education "Promotion Practices Report, Grades X, XI and XII" (Edmonton: Testing and Research Office, 1965), (Mimeographed).

TABLE VI

LEVEL ATTAINED IN PROGRAM

		Quarter in which student dropped out							Failed at end of 9th	Gradua-ted after 3 years	Total
		2nd	3rd	4th	5th	6th	7th	8th			
Sample 3	Alberta Non-Adults	3	6	2	2	5	0	0	1	31	50
	Adults	0	5	0	1	2	0	0	0	7	15
	Non-Alberta	1	1	0	0	1	0	0	0	8	11
	Total Sample 3	4	12	2	3	8	0	0	1	46	76
Sample 4	Alberta Non-Adults	3	6	1	13	0	1	0	6	16	46
	Adults	0	0	0	1	0	0	0	1	4	6
	Non-Alberta	0	0	1	1	1	0	0	0	2	4
	Total Sample 4	3	6	2	14	1	1	0	7	22	56
Total Sample 3 and Sample 4		7	18	4	17	9	1	0	9	67	132

Sample 3 Alberta Non-Adults constitute sample 1.
Sample 4 Alberta Non-Adults constitute sample 2.

TABLE VII

MEANS, STANDARD DEVIATIONS AND RANGES OF GRADE IX PREDICTOR VARIABLES

Variable		Reading %	Literature %	Language %	Soc. Studies %	Math %	Science %	SCAT total %tile	SCAT Verbal stanine	SCAT Quan. stanine
Sample 1 (N = 50)	mean	54.0	54.3	53.5	58.5	62.7	64.8	53.6	4.94	5.2
	standard deviation	11.0	9.0	8.6	11.6	9.0	9.6	24.1	1.0	1.6
	range	30-76	38-72	40-69	43-79	42-82	45-83	9-88	1-8	3-9
Sample 2 (N = 46)	mean	56.8	53.0	54.9	60.0	59.4	64.0	52.4	5.2	5.0
	standard deviation	14.7	10.9	11.2	9.7	13.5	11.1	22.1	1.8	1.4
	range	26-90	30-80	39-80	43-79	30-86	47-86	9-96	1-9	2-8

TABLE VIII

MEANS, STANDARD DEVIATIONS AND RANGES OF GRADE 10 AND 11 PREDICTOR VARIABLES

Variable		Lang. 10 & 20 Ave. %	Soc. Studies 10 & 20 Ave. %	Math. 10 & 20 or 12 & 22 Ave. %	Science 10 & 20 Ave. %	Math. & Science Ave. %
Sample 1 (N = 50)	mean	54.3	56.2	57.6	58.9	58.3
	standard deviation	6.7	11.0	6.8	7.0	5.4
	range	45-68	40-75	45-78	45-80	50-75
Sample 2 (N = 46)	mean	54.6	57.5	56.8	57.4	57.1
	standard deviation	9.1	9.3	6.3	6.4	5.6
	range	42-72	40-82	50-70	50-72	51-71

TABLE IX

MEANS, STANDARD DEVIATIONS AND RANGES OF D.A.T. PREDICTOR VARIABLES

D.A.T. Variables % tile		A.R.	C.S. & A.R.	M.R.	N.A.	Spelling	Sentences	S.R.	V.R.	V.R. & N.A.
Sample 1 N = 50	Mean	71.4	53.5	66.9	82.7	54.8	46.6	64.5	64.0	76.3
	Standard Deviation	22.9	28.1	25.8	14.3	26.5	26.4	25.6	23.6	17.5
	Range	20-99	05-97	03-99	40-99	01-90	05-95	05-99	10-97	25-97
Sample 2 N = 46	Mean	67.7	35.5	75.6	79.9	29.6	57.7	58.6	62.0	71.7
	Standard Deviation	23.4	21.4	21.4	12.0	28.6	21.5	20.9	21.7	13.5
	Range	10-99	05-99	05-97	50-97	01-90	10-95	05-99	10-95	35.97

"Continued"

TABLE IX "CONTINUED"

D.A.T. Variables % tile		A.R.	C.S. & A.R.	M.R.	N.A.	Spelling	Sentences	S.R.	V.R.	V.R. & N.A.
Sample 3 N = 76	Mean	68.9	50.8	68.1	81.9	59.9	48.2	62.2	63.0	75.1
	Standard Deviation	23.5	29.0	24.8	13.9	24.9	25.9	26.3	22.7	17.3
	Range	20-99	5-97	03-99	40-99	01-99	05-95	05-99	10-97	25.97
Sample 4 N = 56	Mean	66.7	36.7	75.8	79.6	31.9	58.8	59.7	63.0	71.9
	Standard Deviation	24.9	22.1	22.1	12.5	29.2	20.9	21.0	21.8	14.5
	Range	10-99	5-99	5-99	50-97	01-90	10-95	05-99	10-95	35-97

II. NULL HYPOTHESIS AND ZERO ORDER CORRELATIONS

Null Hypothesis One states:

There is no significant correlation at the .05 level of significance between each of Language 10 and 20 average, Social Studies 10 and 20 average, Mathematics 10 and 20 or 12 and 22 average, Science 10 and 20 average, average of Mathematics 10 or 12, Mathematics 20 or 22, Science 10, Science 20, and:

1a. relative success to the end of Year A of the N.A.I.T. three year Electronics program.

1b. relative success to the end of Year B of the N.A.I.T. three year Electronics program.

1c. relative success to the end of Year C of the N.A.I.T. three year Electronics program.

Table X on page 61 consists of the correlations pertinent to Hypothesis One and Table XI on page 62 is a summary of the results for the hypothesis.

Null Hypothesis Two states:

There is no significant correlation at the .05 level of significance between each of the grade IX predictor variables (XI - X9) and:

2a. relative success to the end of Year A of the N.A.I.T. three year Electronics program.

2b. relative success to the end of Year B of the N.A.I.T. three year Electronics program.

2c. relative success to the end of Year C of the N.A.I.T. three year Electronics program.

Table XII on page 63 consists of the correlations pertinent to Hypothesis Two and Table XIII on page 64 is a summary of the results

for the hypothesis.

Null Hypothesis Three states:

There is no significant correlation at the .05 level of significance between the grade 9 academic average, ($X23 = \frac{X1 + X2 + X3 + X4 + X5 + X6}{6}$) the grade 10 and 11 academic average ($X24 = \frac{X10 + X11 + X12 + X13}{4}$) and:

3a. relative success to the end of Year A of the N.A.I.T. three year Electronics program.

3b. relative success to the end of Year B of the N.A.I.T. three year Electronics program.

3c. relative success to the end of Year C of the N.A.I.T. three year Electronics program.

Table XIV on page 65 consists of the correlations pertinent to Hypothesis Three and Table XV on page 66 is a summary of the results for the hypothesis.

Null Hypothesis Four states:

There is no significant correlation at the .05 level between each of the D.A.T. subtest scores (X14 - X22), and:

4a. relative success to the end of Year A of the N.A.I.T. three year Electronics program.

4b. relative success to the end of Year B of the N.A.I.T. three year Electronics program.

4c. relative success to the end of Year C of the N.A.I.T. three year Electronics program.

Table XVI on page 67 consists of the correlations pertinent to Hypothesis Four and Table XVII on page 69 is a summary of the results for the hypothesis.

Null Hypothesis Five states

There is no significant correlation at the .05 level of significance between:

5a. relative success to the end of Year A (Y1), of the N.A.I.T. three year Electronics program and relative success to the end of Year B (Y2) of the N.A.I.T. three year Electronics program.

5b. relative success to the end of Year A (Y1), of the N.A.I.T. three year Electronics program and relative success to the end of Year C (Y3), of the N.A.I.T. three year Electronics program.

5c. relative success to the end of Year B (Y2), of the N.A.I.T. three year Electronics program and relative success to the end of Year C (Y3), of the N.A.I.T. three year Electronics program.

The data in Table XVIII, page 71, indicates that Null Hypothesis 5a, 5b and 5c can be rejected at the .05 level of confidence for all samples.

Table XIX, page 72, is a summary of criterion intercorrelations for those who remained in the program over its entire length. The criterion intercorrelations indicate a fairly high degree of relationship between relative performance in the different years of the program. The criterion intercorrelations on Table XIX are somewhat lower than those shown on Table XVIII. A major reason for this is that, according to the relative success definition, students who dropped out during one year of the program automatically were assigned the same criterion score for subsequent years of the program.

TABLE X

ZERO ORDER CORRELATIONS BETWEEN GRADE 10 AND 11 PREDICTOR VARIABLES AND CRITERION SCORES

Grade 10 and 11 Predictor Variables %		X10 Language Ave.	X11 Soc.Studies Ave.	X12 Math. Ave.	X13 Physical Science Ave.	X25 Math-Science Ave.
	Y1 Success to end Year A			.45*	.45*	.57*
Sample 1 (N = 50)	Y2 Success to end Year B			.46*	.40*	.54*
	Y3 Success to end Year C			.41*		.44*
	Y1 Success to end Year A		.34	.38*	.50*	.50*
Sample 2 (N = 46)	Y2 Success to end Year B		.40*		.34	.32
	Y3 Success to end Year C		.41*	.32	.38*	.40*

Only r's significant at the .05 level were printed, see Appendix A for complete correlation matrix.

*Indicates significance at the .01 level.

TABLE XI

RESULTS FOR NULL HYPOTHESIS ONE

High School Predictor Variables	Sample 1			Sample 2		
	Hypothesis 1a	Hypothesis 1b	Hypothesis 1c	Hypothesis 1a	Hypothesis 1b	Hypothesis 1c
XI0 Language Ave.	accept	accept	accept	accept	accept	accept
XII Social Studies Ave.	accept	accept	accept	reject	reject	reject
X12 Math. Ave.	reject	reject	reject	reject	accept	reject
X13 Physical Science Ave.	reject	reject	accept	reject	reject	reject
X25 Math-Science Ave.	reject	reject	reject	reject	reject	reject

Significance level for rejecting hypothesis equals .05

TABLE XII

CORRELATIONS BETWEEN GRADE IX PREDICTOR VARIABLES AND CRITERIA

Grade IX Predictor Variables		X1 Reading %	X2 Lit. %	X3 Lang. %	X4 Social Studies %	X5 Math. %	X6 Science %	X7 SCAT tot. % tile	X8 SCAT V Stanine	X9 SCAT Q Stanine
Sample 1 (N = 50)	Y1 Success to end Year A					.39*				
	Y2 Success to end Year B					.32				
	Y3 Success to end Year C					.32				
Sample 2 (N = 46)	Y1 Success to end Year A				.33	.31				
	Y2 Success to end Year B				.35					
	Y3 Success to end Year C				.41*					

Only r's significant at the .05 level were printed, see Appendix A for complete correlation matrix.

*Indicates significance at the .01 level.

TABLE XIII

RESULTS FOR NULL HYPOTHESIS TWO

Grade IX Predictor Variables	Sample 1			Sample 2		
	Hypothesis 1a	Hypothesis 1b	Hypothesis 1c	Hypothesis 1a	Hypothesis 1b	Hypothesis 1c
X1 Reading %	accept	accept	accept	accept	accept	accept
X2 Literature %	accept	accept	accept	accept	accept	accept
X3 Language %	accept	accept	accept	accept	accept	accept
X4 Social Studies %	accept	accept	accept	reject	reject	reject
X5 Mathematics %	reject	reject	reject	reject	accept	accept
X6 Science %	accept	accept	accept	accept	accept	accept
X7 S.C.A.T. Total % tile	accept	accept	accept	accept	accept	accept
X8 S.C.A.T. Verbal Stanine	accept	accept	accept	accept	accept	accept
X9 S.C.A.T. Quant. Stanine	accept	accept	accept	accept	accept	accept

Significance level for rejecting hypothesis equals .05

TABLE XIV

ZERO ORDER CORRELATIONS BETWEEN HIGH SCHOOL AVERAGES AND CRITERION SCORES

Predictor	Variable 1	X23 Grade IX Academic Ave.	X24 Grade 10 and 11 Academic Ave.
Sample 1 (N = 50)	Y1 Success to End Year A		.47*
	Y2 Success to End Year B		.40*
	Y3 Success to End Year C		.33
Sample 2 (N = 46)	Y1 Success to End Year A		.52*
	Y2 Success to End Year B		.32
	Y3 Success to End Year C		.38*

Only r's that are significant at the .05 level were printed.

See Appendix A for complete correlation matrix.

* denotes significance at the .01 level

TABLE XV

RESULTS FOR NULL HYPOTHESIS THREE

Predictor Variables	Sample 1			Sample 2		
	Hypothesis 3a	Hypothesis 3b	Hypothesis 3c	Hypothesis 3a	Hypothesis 3b	Hypothesis 3c
X24 Grade IX Academic Average	accept	accept	accept	accept	accept	accept
X25 Grade 10 and 11 Academic Average	reject	reject	reject	reject	reject	reject

Significance level for rejecting hypothesis equals .05

TABLE XVI

CORRELATIONS BETWEEN D.A.T. PREDICTOR SCORES AND CRITERION SCORES

	Predictor Variables % tile	X14 A.R.	X15 C.S.&A.	X16 M.R.	X17 N.A.	X18 Spelling	X19 Sentences	X20 S.R.	X21 V.R.	X22 V.R. & N.A.
Sample 1 (N = 50)	Y1 Success to End Year A	.38*		.29	.49*			.33		
	Y2 Success to End Year B	.28			.41*					
	Y3 Success to End Year C	.36*			.39*					
Sample 2 (N = 46)	Y1 Success to End Year A				.49*			.32		.30
	Y2 Success to End Year B							.29		
	Y3 Success to End Year C				.33					

Only r's significant at the .05 level were printed.

* indicates significance at the .01 level

See Appendix A for complete correlation matrix.

For definition of variables X14 - X22, see page 47.

TABLE XVI "Continued"

Predictor Variables % tile		X14 A.R.	X15 C.S.&A.	X16 M.R.	X17 N.A.	X18 Spelling	X19 Sentences	X20 S.R.	X21 V.R.	X22 V.R.& N.A.
Sample 3 (N = 76)	Y1 Success to End Year A	.34		.23	.40*			.29		
	Y2 Success to End Year B	.27			.36*					
	Y3 Success to End Year C	.31			.36*			.23		
Sample 4 (N = 56)	Y1 Success to End Year A		.31		.32			.44*		
	Y2 Success to End Year B									
	Y3 Success to End Year C							.27		

Only r's significant at the .05 level were printed.

* indicates significance at the .01 level.

See Appendix A for complete correlation matrix.

For definition of variables X14 - X22, see page 47.

TABLE XVII

RESULTS FOR NULL HYPOTHESIS FOUR

D.A.T. Predictor Variables	Sample 1			Sample 2		
	Hypothesis 5a	Hypothesis 5b	Hypothesis 5c	Hypothesis 5a	Hypothesis 5b	Hypothesis 5c
X14 Abstract Reasoning	reject	reject	reject	accept	accept	accept
X15 Clerical Speed and Accuracy	accept	accept	accept	accept	accept	accept
X16 Mechanical Reasoning	reject	accept	accept	accept	accept	accept
X17 Numerical Ability	reject	reject	reject	reject	accept	reject
X18 Spelling	accept	accept	accept	accept	accept	accept
X19 Sentences	accept	accept	accept	accept	accept	accept
X20 Spatial Relations	reject	accept	accept	reject	reject	accept
X21 Verbal Reasoning	accept	accept	accept	accept	accept	accept
X22 Verbal Reasoning plus Numerical Ability	accept	accept	accept	accept	accept	accept

Significance level for rejecting hypothesis equals .05

TABLE XVII "Continued)

RESULTS FOR NULL HYPOTHESIS FOUR

D.A.T. Predictor Variables	Sample 3			Sample 4		
	Hypothesis 5a	Hypothesis 5b	Hypothesis 5c	Hypothesis 5a	Hypothesis 5b	Hypothesis 5c
X14 Abstract Reasoning	reject	reject	reject	accept	accept	accept
X15 Clerical Speed and Accuracy	accept	accept	accept	reject	accept	accept
X16 Mechanical Reasoning	reject	accept	accept	accept	accept	accept
X17 Numerical Ability	reject	reject	reject	reject	accept	accept
X18 Spelling	accept	accept	accept	accept	accept	accept
X19 Sentences	accept	accept	accept	accept	accept	accept
X20 Spatial Relations	reject	accept	reject	reject	accept	reject
X21 Verbal Reasoning	accept	accept	accept	accept	accept	accept
X22 Verbal Reasoning plus Numerical Ability	accept	accept	accept	reject	accept	accept

Significance level for rejecting hypothesis equals .05

TABLE XVIII

INTERCORRELATIONS BETWEEN CRITERION VARIABLES

	Sample 1 N = 50			Sample 2 N = 46			Sample.3 N = 76			Sample 4 N = 56		
	Y1	Y2	Y3	Y1	Y2	Y3	Y1	Y2	Y3	Y1	Y2	Y3
Y1	1.00	.87	.85	1.00	.69	.71	1.00	.92	.90	1.00	.77	.79
Y2		1.00	.98		1.00	.94		1.00	.97		1.00	.97
Y3			1.00			1.00			1.00			1.00

all correlations significant at the .01 level

TABLE XIX

INTERCORRELATIONS BETWEEN CRITERION VARIABLES

FOR THOSE WHO REMAINED IN PROGRAM NINE QUARTERS

	From Sample 1 N = 32			From Sample 2 N = 23			From Sample 3 N = 47			From Sample 4 N = 29		
	Y1	Y2	Y3	Y1	Y2	Y3	Y1	Y2	Y3	Y1	Y2	Y3
Y1	1.00	.82	.76	1.00	.53	.42*	1.00	.85	.79	1.00	.77	.79
Y2		1.00	.83		1.00	.87		1.00	.88		1.00	.97
Y3			1.00			1.00			1.00			1.00

* denotes significance at the .05 level

all other correlations significant at the .01 level

III. REGRESSION EQUATIONS

Regression equations were arrived at by means of the Reg. 300 Stepwise Multiple Linear Regression computer program, with significance levels for variables entering and leaving each equation being set at the .05 level. All the regression equations produced by the computer for predicting criterion scores on the basis of sample 1 data are listed in Table XX, page 75.

The seven regression equations produced in the Reg. 300 process were then cross-validated on the data from sample 2. Table XXI, page 76, is a summary of the results of the cross validation.

Upon cross validation, equation B was found to be the best, having not only the highest shrunken R with Y1, the criterion variable for which is was calculated, but also the highest correlations with Y2 and Y3 from sample 2. Equation F was selected as being the second best equation in that it had the second best correlation with Y3 from sample 2, and in that it included only 2 predictor variables versus 3 for equation C.

For the two selected combinations of variables, X13 with X17 (from equation B), and X12 and X13 (from equation F), the optimum Beta weights for predicting each of the 3 criterion variables for sample 1 were calculated using the method outlined by Ferguson.[2]

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[2] George A. Ferguson, Statistical Analysis in Psychology and Education, Edition 2, (McGraw Hill Book Co., New York: 1966), pp.390-394

Equation B1 $Y1 = 0.514\ X13 + 0.286\ X17 - 4.0$

Equation B2 $Y2 = 0.457\ X13 + 0.233\ X17 + 3.9$

Equation B3 $Y3 = 0.286\ X13 + 0.240\ X17 + 13.4$

Equation F1 $Y1 = 0.541\ X12 + 0.532\ X13 - 12.3$

Equation F2 $Y2 = 0.574\ X12 + 0.443\ X13 - 9.2$

Equation F3 $Y3 = 0.519\ X12 + 0.278\ X13 + 3.7$

The zero order correlations between sample 2 criteria and the regression scores calculated on the basis of equations B1 - F3 were then found. Table XXII, page 77 is a summary of those correlations.

TABLE XX

REGRESSION EQUATIONS FOR SAMPLE 1
PRODUCED BY REG. 300

Equation Designation	Equation	R^2	R	Probability Level
A	$Y1 = 0.346\,X17 + 21.402$	.247	.50	.000245
B	$Y1 = 0.514\,X13 + 0.286\,X17 - 4.007$	.368	.61	.000021
C	$Y1 = 0.644\,X13 + 0.144\,X14 + 0.145\,X17 - 10.238$	.436	.66	.000007
D	$Y1 = 0.738\,X13 + 0.197\,X14 - 7.605$	.410	.63	.000004
E	$Y2 = 0.681\,X12 + 10.767$	.219	.47	.000614
F	$Y2 = 0.574\,X12 + 0.443\,X13 - 9.178$	.312	.56	.000162
G	$Y3 = 0.617\,X12 + 14.482$	.178	.42	.002248

Significance Level for variables entering and leaving = .05

The seven regression equation produced in the Reg. 300 process were cross-validated on the data from sample 2.

TABLE XXI

CROSS VALIDATION OF REGRESSION EQUATIONS

FROM SAMPLE ONE ON THE DATA FROM SAMPLE TWO

Equation	Multiple Correlations with Criterion Variable from Sample 1			Zero Order Correlation with Sample 2 Criterion Variables		
	Y1	Y2	Y3	Y1	Y2	Y3
A	.50			.48	.29	.30
B	.61			.62	.40	.43
C	.66			.56	.34	.32
D	.63			.45	.14	.23
E		.47		.38	.22	.33
F		.56		.49	.31	.40
G			.42	.38	.22	.33

TABLE XXII

CORRELATIONS BETWEEN SELECTED REGRESSION EQUATIONS WITH OPTIMUM BETA WEIGHTS CALCULATED FOR SAMPLE 1 AND CRITERION VARIABLES FOR SAMPLE ONE AND SAMPLE TWO

Equation	Sample 1 N = 50			Sample 2 N = 46		
	Y1	Y2	Y3	Y1	Y2	Y3
B1	.61	.51	.43	.62	.40	.43
B2	.59	.51	.42	.62	.40	.43
B3	.59	.50	.43	.61	.39	.42
F1	.57	.54	.44	.40	.32*	.40
F2	.57	.55	.45	.49	.31*	.40
F3	.55	.54	.45	.47	.29*	.39

* Indicates significance at the .05 level. All other correlations significant at the .01 level.

The combination of X17 and X13 (Equation B) are shown to be superior to the combinations of X12 and X13 (Equation F) for prediction of relative success to the end of Year A of the three year Electronics program. However, the two combinations are shown to be equally effective for prediction of relative success to the end of the program (Y3).

For the purpose of counselling the student as to what level of relative success he can expect over the length of the program, the criterion variable Y3 is the most important. Also, the high

school math and science grades are available before the student enters the program. Therefore, the combination of high school math and physical science grades was selected as the optimum predictor.

The data in Table XXII indicates that there is little to choose between the trial Beta weights. Also the math-science average (X25), was found to correlate with Y3 as well as the regression combinations of the same variables.[3]

Therefore expectancy tables were based on the math-science average with a Beta weight of 1.

The regression equations produced on the basis of sample 3 data, in the steps of the Reg. 300 Stepwise Multiple Linear Regression procedure, are listed in Table XXIII, on the following page.

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[3] See Table X, page 61

TABLE XXIII

REGRESSION EQUATIONS FOR SAMPLE 3

PRODUCED BY REG. 300 N = 76

Equation Designation		R	R^2	Probability Level
H	$Y1 = 0.288\ X17 + 26.268$	0.40	0.159	.000365
I	$Y2 = 0.263\ X17 + 28.403$	0.36	0.132	.001249
J	$Y2 = 0.334\ X17 - 0.106\ X21 + 29.243$	0.42	0.179	.000743
K	$Y3 = 0.264\ X17 + 28.420$	0.36	0.133	.000760
L	$Y3 = 0.339\ X17 - .104\ X21 + 29.251$	0.42	0.179	.000760

Significance level for variables entering and leaving = 0.05

The regression equations developed on the basis of data from sample 3 were then cross-validated on the data from sample 4. The results of the cross-validation procedure are summarized in Table XXIV on the following page.

TABLE XXIV

CROSS-VALIDATION OF REGRESSION EQUATIONS FROM SAMPLE THREE ON THE DATA FROM SAMPLE FOUR

Equation	Multiple Correlation with Criterion Variable from Sample 3 (N = 76)			Zero Order Correlation with Criterion Variables from Sample 4 (N = 56)		
	Y1	Y2	Y3	Y1	Y2	Y3
H	.40			.32		
I & K (identical)		.36	.36	.32		
J		.42				
L			.42			

All multiple R's significant at .01 level

Only zero order correlations with sample 4 criteria significant at the .05 level were printed.

The data in Table XXIV indicates that none of the regression equations developed for sample 3 data were significant at the .05 level for predicting relative success to the ends of Years B and C for sample 4.

IV. EXPECTANCY TABLES

TABLE XXV

EXPECTANCY TABLE FOR ALBERTA NON-ADULT STUDENTS ENTERING THE N.A.I.T. THREE YEAR ELECTRONICS PROGRAM

Math-Science Average %	Number Graduated	Number Failed	Totals
75 - 79	1	0	1
70 - 74	4	0	4
65 - 69	4	4	8
60 - 64	15	3	18
55 - 59	15	21	36
50 - 54	8	21	29
Totals	47	49	96

based on emperical data from those students who entered the three year Electronics program in 1965 and in 1966.

includes those students who obtained their post grade 8 high school training in Alberta and who wrote Grade IX Departmentals within 6 years of entering the N.A.I.T. program

Students who withdrew from the N.A.I.T. program with an average in their last quarter of greater than 55% and who failed no courses in their last quarter were not included.

Math-science average equals average of final grades (%) in math 10 or 12, math 20 or 22, science 10 and science 20.

TABLE XXVI

EXPECTANCY TABLE FOR ALBERTA NON-ADULT STUDENTS ENTERING N.A.I.T.

THREE YEAR ELECTRONICS PROGRAM

Math-Science Average %	Expected T Score	Expected Rank % tile	Chances are 2 in 3 that % tile Rank Will be between	Chances of Being in top half of class (Percent)	Chances of being in top quarter of class (percent)
78 - 79	71	98	91 - 99.1	99.7	97
76 - 77	69	97	87 - 99.6	99.3	94
74 - 75	67	95	82 - 99.3	98.6	91
72 - 73	65	93	76 - 99	97	85
70 - 71	63	90	70 - 98	95	79
68 - 69	61	86	63 - 97	92	70
66 - 67	59	81	55 - 95	87	60
64 - 66	57	75	47 - 93	81	50
62 - 63	55	68	39 - 89	74	40
60 - 61	53	61	32 - 85	64	30
58 - 59	51	53	25 - 80	54	21
56 - 57	49	45	19 - 74	44	15
54 - 55	47	37	14 - 67	34	9
52 - 53	45	30	10 - 59	25	6
50 - 51	43	24	7 - 52	17	3
48 - 49	41	18	5 - 44	11	2

See Appendix B for sample calculations.

CHAPTER V

SUMMARY, DISCUSSION AND CONCLUSIONS AND RECOMMENDATIONS

I. SUMMARY, DISCUSSION AND CONCLUSIONS

The purpose of this study was to obtain information which could be useful for the prediction of relative success in the N.A.I.T. three year Electronics program, to provide some descriptive statistics as to the nature of the students who entered the program in 1965 and 1966 with respect to high school achievement scores and aptitude measures, and to provide some information as to the stability of relative performance over the length of the N.A.I.T. three year Electronics program. An attempt was made to find useful predictor combinations from the D.A.T. subtest scores for the total groups which entered the program, and also to find useful predictor combinations from Alberta Grade IX Departmental Examination scores, Alberta Grade 10 and 11 academic course grades, and the D.A.T. subtest scores, for those Alberta non-adult students entering the program. Alberta non-adult students were defined as those students who had written their Alberta Grade IX Departmental Examinations within six years of entering the program and who had obtained their grade 10 and 11 schooling in Alberta. The total group included, in addition to Alberta non-adult students, Alberta adult students and non-Alberta students.

Sample 3 consisted of those 76 students who entered the program in 1965, for whom complete predictor data was available,

and who did not withdraw for reasons other than poor achievement. Sample 1 consisted of the 50 Alberta non-adult students who were included in sample 3. Sample 4 consisted of those 56 students who entered the program in 1966 and who met the same conditions as those listed for sample 3. Sample 2 consisted of the 46 Alberta non-adult students included in sample 4.

Criterion scores were relative success (T scores, mean 50, standard deviation 10) to the end of each of the three years of the Electronics program. Relative success was defined as rank in class based on the weighted average of final grades in that year of the program under consideration. Students who dropped out before the end of that year were ranked below those who did not drop out, according to length of time in the program. Students who dropped out in the same quarter were ranked according to weighted average in the last complete quarter.

Means, standard deviations and ranges of predictor variables were determined and tabulated.[1] The level of achievement of the Alberta non-adult students in the Grades IX, X and XI academic courses was found to be centered very closely around the middle achievement range for the total Alberta high school population.[2]

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[1] See Tables VII - IX, pages 54 - 56.

[2] Alberta Department of Education "Promotion Practices Report, Grades X, XI and XII" (Edmonton: Testing and Research Office, 1965), (Mimeographed.)

None of the students had markedly superior scores or markedly inferior scores. The Grade IX Departmental Examination scores were found to be considerably lower than those of the students in Black's[3] study on the relationship between Grade IX results and university freshman success, where the averages tended to lie between 75 and 80%.

The admission requirements for the Electronics program (67 high school credits and 50% or better in Mathematics 20 or 22), may be part of the reason why there were no markedly inferior academic scores.

The results of the D.A.T. battery indicated a wide variation in the aptitudes of the students. Some students made markedly superior scores while others made markedly inferior scores on each D.A.T. subtest, except for the Numerical Ability subtest in which no markedly inferior scores were recorded. Students in all four samples achieved the best average on the D.A.T. Numerical Ability subtest, with the next three highest scores being achieved on the Mechanic Reasoning, Abstract Reasoning and Verbal Reasoning plus Numerical Ability subtests.

Average scores on the above mentioned D.A.T. subtests were

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[3] Donald B. Black, "The Prediction of University Freshman Success Using Grade IX Departmental Scores," Alberta Journal of Educational Research, Vol. 5, No. 4, 1959, pp. 229 - 239.

considerably above the fiftieth percentile point, However, observations regarding the superiority or inferiority of the samples should be made with caution, as the norms used were based on the results for Grade 12 students in the U.S.A.

In comparing sample 1 with sample 3, and sample 2 with sample 4, no marked difference in D.A.T. subtest means was found to be evident. This would indicate that non-Alberta and adult students in the samples were not markedly different from the Alberta non-adult students with respect to aptitudes as measured by the D.A.T.

Caution should be exercised in comparing the D.A.T. results for samples 1 and 3 with the results for samples 2 and 4, as different forms of the D.A.T. were administered to the two pairs of samples, and they were administered at points 3 months apart in the Electronics program.

Zero order correlations between all predictor variables and all criterion variables were determined and tabulated.[4] For Alberta non-adult students, the high school math-science average was found to be the most significant and consistent predictor of relative success over the length of the three year Electronics program.

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[4] See Tables X, XII, XIV, XVI and Appendix A.

The math-science average was found to be a significant (.05 level) predictor of relative success to the ends of each of the three years of the Electronics program for each of two independent samples. The high school academic average was also found to be a consistently significant (.05 level) predictor of relative success to the end of each of the three years of the Electronics program for each of two independent samples. However, the correlations between criterion scores and the academic average were found to be lower than those between criterion scores and math-science average.

The high school math average, high school science average and D.A.T. Numerical Ability scores were also found to be fairly good predictors of relative success in the Electronics program. However, they were not found to be significant (.05 level) consistently enough to warrant their use in counselling without further investigation.

Language grades, S.C.A.T. scores, grade IX academic average and the remainder of the D.A.T. subtest scores were found to be of little value as predictors of success in the Electronics program.

The fact that the high school math-science average was found to be the best single predictor of relative success in the N.A.I.T. three year Electronics program is in agreement with Geiss'[5] conclusion

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[5] Almon Lewis Geiss, "An Analysis of Relationships Between Courses Taken in High School and Success in Specific areas at the Oregon Technical Institute", Doctoral Dissertation, (Washington State University, 1966), and Ann Arbor, Michigan, University Microfilms, 1966, p. 96.

that physics, mathematics and chemistry correlated most highly with success in engineering technologies at the Oregon Technical Institute.

Price's[6] finding that the Lorge Thorndike Intelligence test was of little value for predicting first quarter weighted average in the N.A.I.T. Electronics program appears to be in agreement with the findings of this study in that S.C.A.T. scores and the D.A.T. general intelligence measure (Verbal Reasoning plus Numerical Ability) were not found to be good predictors of relative success in the same program. This would indicate that general intelligence measures are likely to be of little value as predictors of success in Electronics at N.A.I.T., at least for those students who have achieved to the level of present admission requirements.

The fact that grade IX Reading, Literature and Language, high school Language, and D.A.T. Verbal, Spelling, and Sentences were not found to be significant predictors (.05 level) of any of the criterion scores for any of the samples indicates that success in the N.A.I.T. Electronics program has little dependence on verbal factors, at least not at the ability levels of the students who have achieved to the level of present admission requirements.

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[6] Donald W. Price, "Predictive Validity of the D.A.T. Subtest Scores and the Lorge Thorndike Subtest Scores on Year A Students at N.A.I.T." (Unpublished Institutional Study, Northern Alberta Institute of Technology, Edmonton, 1967), p. 7.

For the samples which included adult and non-Alberta students (samples 3 and 4) the D.A.T. Numerical Ability subtest was found to have the highest average correlation with criterion scores. However, the correlations between Numerical ability scores and relative success to the end of each of the three years of the Electronics program were found to be lower for sample 3 than for sample 1, and lower for sample 4 than for sample 2. Sample 1 consisted of the non-adult Alberta students in sample 3, and sample 2 consisted of the non-adult Alberta students in sample 4. This result would therefore seem to indicate that the relative success of adults and/or non-Alberta students in Electronics is not as predictable by means of the D.A.T. Numerical ability subtest as is the relative success of non-adult Alberta students.

Intercorrelations between criterion scores for each of the four samples, and for those in each of the four samples who remained in the program over its entire length were determined and tabulated.[7]

A high degree of relationship was found between relative success to the ends of each of the three years of the N.A.I.T. Electronics program. Sample 2 had the lowest criterion intercorrelations, with first year relative success accounting for 50% of

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[7] See Tables XVIII and XIX, pages 71 - 72.

the variance in relative success to the end of third year.

The criterion intercorrelations for the samples are useful as an indication of how well a student will do in later years of the program compared to the groups with which he entered the program. However, a more meaningful measure of the stability of relative performance in different years of the program is provided by criterion intercorrelations for those students who remained in the program over its entire length.

The criterion intercorrelations for each of the four subgroups[8] who remained in the program over its entire length were found to be significant at the .05 level in all cases. Group 2a was found to be the least stable, where Year A relative success accounted for 17% of the variance in relative success to the end of Year C. For this group the correlation between relative success to the end of Year A and relative success to the end of Year C ($r = 0.42$) is in the same order of magnitude as that reported by Evanson and Smith[9] for correlation between first and third year university average ($r = 0.45$), of students graduating from the

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[8] For definition of groups, see page 13.

[9] A. B. Evanson and D. E. Smith, "A Study of Matriculation in Alberta," Alberta Journal of Educational Research, Vol. 4, No. 2, 1957, p. 70.

University of Alberta in three years.

For groups 1, 3 and 4 the correlations between relative success to the end of Year A and relative success to the end of Year C were found to be 0.76, 0.79, and 0.79 respectively. These correlations are in the same order of magnitude as the median intercorrelations between college grades in adjacent semesters (median r = 0.79) and higher than those for college grades 3 semesters apart (median r = 0.66), reported by Bloom[10] for a group of American colleges.

The data therefore indicates that relative performance over the length of the N.A.I.T. three year Electronics program is at least as stable as the performance of college students from one year to the next.

The criterion intercorrelations for group 3a were greater than those for subgroup 1a in each of the 3 corresponding cases, and the criterion intercorrelations for group 4a were found to be higher than those for group 2a in each of the 3 corresponding cases. Group 1a consists of the Alberta non-adult students in group 3a and group 2a consists of the Alberta non-adult students in group 4a. The data, therefore indicates that the relative performance of adult and/or non-Alberta students is more stable over the length of the

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[10] Benjamin S. Bloom and Frank R. Peters, "The Use of Academic Prediction Scales for Counselling and Selecting College Entrants" The Free Press of Glenco, New York: 1961), p. 37.

Electronics program than is the relative performance of Alberta non-adults.

However, considering the small numbers of the different categories of students included in each of the groups, the result regarding the relative stability of performance of the different categories of students should not be considered definitive without confirmation by further study.

A stepwise multiple linear regression procedure was used to establish predictor equations on the basis of the data from the samples of the group which entered the program in 1965. The regression equations were cross-validated on the data from the samples of the group which entered the program in 1966.

For Alberta non-adult students (sample 1) a number of the regression equations were found to have higher correlations with criterion scores than any of the individual predictors that were tested. When the regression equations for the data from sample 1 were cross-validated on the data from sample 2, the regression scores for most of the equations were found to have lower correlations with the sample 2 criterion scores than did the high school math-science average. Two exceptions were a regression combination of D.A.T. Numerical Ability and high school Science, and a regression combination of high school Math and high school Science.

The regression combination of D.A.T. Numerical Ability and high school Science was found to have the highest average corre-

lation with criterion scores for sample 1 and for sample 2. However, the regression equation was not found to be superior to the high school math-science average as a predictor of relative success to the end of the third year of the program. The regression combination of high school Math and high school Science also was not found to be superior to the math-science average as a predictor of relative success to the end of the third year of the program.

The shrinkage of the correlation coefficients upon cross-validation of the regression equations, to the point where the regression equations were very little better than math-science average as predictors of relative success, is in close agreement with the findings of Wessman and Bennet.[11] They[12] concluded that a simple average is often found to be as effective a predictor as a regression combination of the predictor scores when the regression equations are cross-validated.

For the samples which included adult and non-Alberta students the problem of shrinkage of correlation coefficients when the regression equations were cross-validated was more serious than for the Alberta non-adult samples. For sample 3, regression equations based on D.A.T. scores were found to have significant

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[11] A. E. Wessman and G. K. Bennet, "Multiple Regression vs. Simple Addition of Scores in Prediction of College Grades," Educational and Psychological Measurement, Vol. XIX, No. 2, 1959, p. 243-246.

[12] Ibid., p. 245

correlations (.01 level) with each of the criterion scores. When these equations were cross-validated on the data from sample 4, none of the regression equations were found to be significant (.05 level) predictors of relative success to the end of the second year of the program, or to the end of the third year of the program.[13]

This result tends to confirm Mosier's contention that, if the combining weights of a predictor composite are determined on one sample, the effectiveness of the composite must be determined on another independent sample.[14] Travers[15] also suggested that, when multiple correlation techniques are used, cross-validation should be carried out.

The results of one of Black's [16] studies appear to be at some variance with the results of this study regarding shrinkage

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[13] See Table XXIII and Table XXIV, pp. 79 - 80.

[14] Charles I. Mosier, "Problems and Designs of Cross-Validation," Educational and Psychological Measurement, Vol. II, No. 1, 1951, p. 6.

[15] Robert M. Travers, An Introduction To Educational Research. (New York: The MacMillan Co., 1964), p. 379.

[16] Donald B. Black, "Validity of Regression Equations After Six Years to Predict Freshman Success in Engineering," Alberta Journal of Educational Research, Vol. 10, No. 1, 1964, pp. 125 - 136.

of correlation coefficients. Black[17] found that, when a regression equation developed for predicting freshman success in Engineering at the University of Alberta was applied to a similar group of engineering freshman six years later, the shrinkage of the correlation coefficient was not significant.

One of the reasons for the difference in shrinkage may be that Black[18] used considerably larger samples (validation sample, N = 529). The use of larger samples may reduce the error due to fitting for accidental characteristics of the sample. Larger samples are not possible in the case of the N.A.I.T. three year Electronics program, due to the limitation imposed by the relatively small enrollment.

It was concluded that the results of this study should not be used for counselling adult and non-Alberta prospective Electronics students as to expected level of performance over the length of the N.A.I.T. three year Electronics program. This conclusion was based on the following findings:

1. None of the regression equations developed on the basis of sample 3 data were found to be significant predictors of relative success to the end of the program for sample 4.[19]

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[17] _Ibid._

[18] _Ibid._

[19] See Table XXIII and Table XXIV, pp. 79 - 80.

2. None of the D.A.T. subtests were found to be consistently significant predictors of relative success over the length of the program for both sample 3 and sample 4.[20]

It was concluded that the results of this study would be of value for counselling Alberta non-adult prospective Electronics students as to expected level of relative performance over the length of the N.A.I.T. three year program. This conclusion was drawn on the basis that a number of predictors were found to have significant (.05 level) correlations with relative success to the ends of each of the three years of the Electronics program for each of two independent samples.

The correlation between high school math-science average and relative success to the end of the third year of the N.A.I.T. Electronics program was found to be 0.44 for the case of sample 1, and 0.40 in the case of sample 2.[21] These correlations are in the same order of magnitude as those reported by Evanson and Smith[22] for the relationship between the grade XII average and the average in the graduating year at the University of Alberta. The grade XII average is used as one of the main criteria for admission to the University of Alberta.

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[20] See Table XVI, p. 82.

[21] See Table X, p. 61.

[22] Evanson, *op. cit.*, p. 69

The high school math-science average was selected as the optimum predictor of relative success in the N.A.I.T. three year Electronics program. The reasons are listed below:

1. The math-science average was found to be a consistently significant (.05 level) predictor of relative success over the length of the program.
2. Though the math-science average was found to have a lower correlation with relative success to the end of the first year of the Electronics program than did a regression combination of D.A.T. Numerical Ability and Science average, and a regression combination of Math average and Science average,[23] the correlation of the math-science average with relative success to the end of the third year of the program was as high as that of either of the regression equations. As the prospective student would be most interested in his relative success position to the end of the program, the lower correlation with success at the beginning of the program was not considered serious.
3. The student would usually know his math-science average some months before having to make a final decision

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[23] See Table XXII, p. 77.

regarding entrance into the N.A.I.T. Electronics program.

4. The simple average is more easily calculated than are regression scores.

Expectancy tables[24] were constructed, using the high school math-science average as the predictor of relative success to the end of the third year of the N.A.I.T. Electronics program. These tables should be of value for assisting the prospective Electronics student in making a decision regarding entrance into the program. However, a number of limitations should be kept in mind when applying this data to the decision making situation.

1. Information which applies to a group as a whole does not necessarily apply to any given individual. There are always exceptions.
2. No attempt was made to include psychological and sociological factors in the prediction study. Students who withdrew from the program with an average of at least 55% in their last quarter and who failed no courses in their final quarter were excluded from the samples. Therefore, no claim is made to validity of results of this study for predicting withdrawals.
3. The study was carried out on the basis of samples taken from the groups which entered N.A.I.T. in 1965 and 1966.

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[24] See Table XXV and Table XXVI, pp. 81 - 82.

Since that time changes have taken place in high school math and science courses, and in some of the courses of the N.A.I.T. Electronics program. These changes may affect the validity of the results of this study.

4. The expectancy tables were based on data from samples consisting of Alberta non-adult students. They should not be used for adult students or non-Alberta students.
5. All of the students in the samples had math-science averages which fell between 50% and 80%. Therefore, application of the results of this study to those students whose math-science average does not fall within that range would be risky.
6. Only one female entered the N.A.I.T. three year Electronics program in 1965 and 1966. Therefore, the results of this study may not apply to females.
7. The correlation between math-science average and relative success to the end of the program, while significant, accounts for only 17% of the variance in that criterion score. Therefore a large portion of the variance in relative success to the end of the N.A.I.T. three year Electronics program is accounted for by factors not taken into account in this study.
8. This study was concerned with prediction of success in a particular Electronics program. Predictors of success in a training program are not necessarily valid predictors of success on the job.

III. RECOMMENDATIONS AND IMPLICATIONS FOR FURTHER STUDY

1. If the results of this study are to be used for counselling purposes, consideration should be given to obtaining high school math and science grades in multiples of 5%, rather than the customary letter gradings, as there is considerable difference between the expected performance of students with a math-science average at the lower end of the B letter grading and of students with a math-science average at the upper end of the B letter grading.
2. It may be of value to carry out a validity generalization study on the results of this study for predicting relative success in the N.A.I.T. two year Electronics program.
3. Further work on establishing N.A.I.T. norms for the D.A.T. subtests may improve the predictive validity of the subtest scores.
4. Credit in high school physical science is not a prerequisite for entrance into the N.A.I.T. three year Electronics program. A study of the success of students who enter the program without physical science credits may be of value.
5. The high school physical science course in Alberta has been split into physics and chemistry courses, and the mathematics course in the high school has undergone some changes since the students in the samples entered the N.A.I.T. Electronics program. In addition, some courses in the Electronics program have undergone changes. The

effect of these changes on the validity of the results of this study should be investigated before they are used.

6. An investigation of the predictive validity of standardized tests of science background or science aptitude may be of some value, especially for non-Alberta or adult students.

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APPENDIX A

CORRELATION MATRICES

TABLES XXVII - XXX

TABLE XXVII

CORRELATION MATRIX FOR SAMPLE 1 N = 50

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
X1	1.00	.33	.40	.25	-.03	.40	.69	.79	.28	.41
X2		1.00	.20	.16	-.13	.23	.31	.42	.08	.44
X3			1.00	.21	-.16	.26	.24	.39	-.02	.33
X4				1.00	.22	.42	.33	.30	.13	.24
X5					1.00	.35	.22	.00	.42	-.03
X6						1.00	.46	.45	.24	.47
X7							1.00	.86	.59	.36
X8								1.00	.29	.43
X9									1.00	.09
X10										1.00
X11										
X12										
X13										
X14										
X15										
X16										
X17										
X18										
X19										
X20										
X21										
X22										
Y1										
Y2										
Y3										

TABLE XXVII "Continued"

	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20
X1	.14	-.06	.07	.18	-.09	.41	.15	.20	.50	.20
X2	.30	.00	.05	-.04	-.04	.15	.21	.25	.33	-.10
X3	.17	-.29	.01	-.16	.03	.09	-.06	.29	.30	-.07
X4	.25	.16	.22	-.08	.03	.26	.23	.03	.11	.06
X5	-.21	.32	.17	.28	.18	.30	.38	-.25	.06	.30
X6	.22	.02	.28	-.05	.08	.60	.05	-.02	.23	.24
X7	.19	.06	.19	.32	.02	.52	.45	.29	.44	.39
X8	.19	-.06	.11	.16	.01	.46	.21	.33	.53	.24
X9	-.10	.25	.08	.40	.00	.41	.51	.12	.23	.35
X10	.42	.04	.30	.00	-.10	.22	.27	.21	.16	.18
X11	1.00	.04	.48	-.16	-.04	.14	.21	.22	.10	.12
X12		1.00	.23	.39	.13	.14	.42	-.29	-.09	.26
X13			1.00	-.13	.02	.21	.23	.06	-.04	.12
X14				1.00	.02	.43	.54	-.14	.12	.62
X15					1.00	.08	.08	-.08	-.19	.03
X16						1.00	.26	-.14	.27	.63
X17							1.00	-.01	.19	.38
X18								1.00	.42	-.15
X19									1.00	.14
X20										1.00
X21										
X22										
Y1										
Y2										
Y3										

TABLE XXVII "Continued"

	X21	X22	Y1	Y2	Y3
X1	.56	.48	.06	-.07	-.05
X2	.32	.35	.00	-.02	-.02
X3	.39	.24	-.12	-.21	-.21
X4	.11	.18	.09	-.03	-.08
X5	.05	.21	.39	.32	.32
X6	.21	.20	.19	.09	.09
X7	.67	.71	.21	.09	.05
X8	.67	.61	.06	-.04	-.07
X9	.31	.47	.22	.23	.17
X10	.27	.33	.14	.10	.07
X11	.06	.15	.27	.19	.17
X12	.05	.24	.45	.46	.41
X13	.06	.17	.45	.40	.28
X14	.26	.43	.38	.28	.36
X15	-.12	-.04	.14	.09	.12
X16	.29	.35	.29	.10	.12
X17	.30	.67	.49	.41	.39
X18	.30	.21	-.17	-.16	-.17
X19	.58	.51	-.03	-.09	-.07
X20	.31	.40	.33	.16	.22
X21	1.00	.87	.01	-.08	-.08
X22		1.00	.25	.16	.15
Y1			1.00	.87	.85
Y2				1.00	.93
Y3					1.00

TABLE XXVIII

CORRELATION MATRIX FOR SAMPLE 2 N = 46

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
X1	1.00	.61	.35	.33	.00	.42	.69	.77	.13	.17
X2		1.00	.58	.42	.19	.49	.63	.64	.22	.19
X3			1.00	.02	.14	.15	.47	.34	.26	.02
X4				1.00	.35	.68	.32	.37	.10	.13
X5					1.00	.49	.39	.05	.68	.10
X6						1.00	.51	.46	.33	.16
X7							1.00	.81	.58	.17
X8								1.00	.07	.22
X9									1.00	.09
X10										1.00
X11										
X12										
X13										
X14										
X15										
X16										
X17										
X18										
X19										
X20										
X21										
X22										
Y1										
Y2										
Y3										

TABLE XXVIII "Continued"

	X11	X12	X13	X14	X15	X16	X17	X18	X19
X1	.13	-.27	-.16	.17	.00	.35	-.03	.35	.27
X2	.14	-.02	-.06	.18	.19	.20	.08	.40	.39
X3	-.17	.10	-.12	.24	.14	.17	.06	.24	.56
X4	.60	.08	.29	.07	.25	.01	-.03	.19	.16
X5	.13	.27	.29	.10	.06	-.04	.14	.21	.10
X6	.40	.07	.18	.06	.21	.16	-.10	.17	.23
X7	.08	-.05	.01	.21	-.03	.21	.16	.45	.40
X8	.21	-.20	-.07	.10	-.04	.25	.01	.28	.37
X9	-.04	.22	.17	.22	.05	.02	.27	.40	.10
X10	.21	.03	.17	-.00	.24	-.04	.07	.00	.14
X11	1.00	.12	.45	-.22	.18	-.09	.06	.00	.13
X12		1.00	.55	.18	.13	-.27	.24	.17	-.09
X13			1.00	.12	.08	-.19	.25	.10	.04
X14				1.00	.15	.31	-.01	.33	.11
X15					1.00	.27	.16	.10	.05
X16						1.00	.01	-.14	.16
X17							1.00	.06	-.04
X18								1.00	.16
X19									1.00
X20									
X21									
X22									
Y1									
Y2									
Y3									

TABLE XXVIII "Continued"

	X20	X21	X22	Y1	Y2	Y3
X1	.15	.57	.59	-.04	-.10	-.03
X2	.03	.40	.52	.04	.03	.12
X3	.20	.29	.43	.01	.05	.13
X4	-.02	.18	.24	.33	.33	.41
X5	.24	.06	.11	.31	.18	.23
X6	.07	.21	.23	.21	.09	.15
X7	.36	.56	.70	.15	-.05	.00
X8	.14	.55	.64	.13	.04	.01
X9	.39	.24	.32	.18	.02	.04
X10	-.02	.04	.11	.22	-.07	-.06
X11	-.11	.21	.21	.34	.40	.41
X12	.17	-.17	-.12	.38	.22	.33
X13	.14	.03	.07	.50	.34	.38
X14	.50	.39	.29	.17	-.13	-.04
X15	.07	-.01	.01	.21	.05	.11
X16	.38	.42	.38	.05	-.03	-.05
X17	.34	.03	.38	.49	.29	.30
X18	-.02	.32	.28	.04	.03	.12
X19	.17	.45	.47	.16	.19	.20
X20	1.00	.29	.41	.32	.09	.10
X21		1.00	.84	.19	.11	.12
X22			1.00	.30	.16	.17
Y1				1.00	.69	.71
Y2					1.00	.93
Y3						1.00

TABLE XXIX

CORRELATION MATRIX FOR SAMPLE 3 N = 76

	X14	X15	X16	X17	X18	X19	X20	X21	X22	Y1	Y2	Y3
X14	1.00	.01	.41	.57	-.04	.21	.62	.36	.23	.34	.27	.31
X15		1.00	.01	.02	-.11	-.21	.01	-.04	.16	.02	-.02	.01
X16			1.00	.26	-.07	.36	.52	.30	-.02	.23	.14	.15
X17				1.00	.07	.23	.40	.41	.20	.40	.36	.36
X18					1.00	.42	-.09	.27	-.32	.02	.01	.00
X19						1.00	.20	.52	-.09	.10	.06	.06
X20							1.00	.30	.20	.29	.21	.23
X21								1.00	.07	.02	-.05	-.05
X22									1.00	.19	.19	.21
Y1										1.00	.42	.90
Y2											1.00	.97
Y3												1.00

TABLE XXX

CORRELATION MATRIX FOR SAMPLE 4 N = 56

	X14	X15	X16	X17	X18	X19	X20	X21	X22	Y1	Y2	Y3
X14	1.00	.29	.38	.14	.41	.20	.46	.39	.35	.16	-.05	.00
X15		1.00	.34	.24	.20	.12	.17	.09	.14	.31	.18	.23
X16			1.00	.09	-.10	.19	.44	.44	.41	.19	.09	.08
X17				1.00	.16	.02	.25	.15	.50	.32	.17	.20
X18					1.00	.25	-.02	.34	.33	.03	.01	.06
X19						1.00	.17	.41	.42	.14	.16	.18
X20							1.00	.29	.35	.44	.26	.27
X21								1.00	.86	.21	.09	.10
X22									1.00	.23	.07	.09
Y1										1.00	.97	.79
Y2											1.00	.97
Y3												1.00

APPENDIX B

SAMPLE CALCULATIONS

SAMPLE CALCULATION OF T SCORE

Student designated number 132 from sample 2 (N = 46, dropped out during the 5th quarter after obtaining a weighted average of 39.6% in quarter 4.

number of people from sample 2 in program after 5 quarters = 23

number of people who dropped out at the end of quarter 5 or who obtained an average of greater than 39.6% in quarter 4.. 8

rank in class - student number 132......................... 32

rank in class from the bottom = 46-32 = 14

percentile rank in class = $\frac{100\ (\text{rank} -.5)}{N}$[1] = $\frac{100\ (14 -.5)}{46}$ = 29.4

percentile points below the median.......................... 20.6

standard score[2]...= -.54

T score = 50 + (standard score) 10 = 50 -.54X10 = 45

This T score will be the same for relative success to the end of Year B and to the end of Year C.

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[1] George A. Ferguson, Statistical Analysis in Psychology and Education, (McGraw-Hill Book Company, New York: 1966) p. 259.

[2] Ibid., Table A, p. 402

SAMPLE CALCULATIONS FOR EXPECTANCY TABLE XXVI

Expected T score for relative success - Beta weight x math-science to the end of Year C (Y3)

Ave., (X15) - C

Beta weight[3] = 1

math science average for sample 1 and sample 2................= 57.7

therefore constant...= -7.7

regression equation, Y3 = X25 -7.7

given that X25 equals 60.5 for a particular student

Y3 = 60.5 -7.7...= 52.8

standard score = $\frac{52.8 - 50}{10}$..= +0.28

expected percentile rank[4] = 50 + (.1103) x 100................= 61

standard error of estimate[5] = $Sy\sqrt{1-r} = 10\sqrt{1-.42}$ = 7.6

chances are 2 in 3 that T score = 53 ± 7.6...................= 45.4 - 60.4

T score 45.2 = standard score = $\frac{-4.8}{10}$ = -.48

standard score of -.48 equals percentile rank[6] 50-(.1844) 100 = 32

similarly a T score of 60.4 = standard score +1.02

= percentile rank.. 85

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[3] See page

[4] Ferguson, _op. cit._, p. 402

[5] _Ibid._, p. 126.

[6] _Ibid._, p. 402

standard errors of estimate above 50 % tile point = $\frac{2.8}{7.6}$ = .355

area of normal curve between 50 % tile point and standard score of .355 is (14)[7] 100............................. = 14%

therefore chances of achieving at least 50%tile = 50% + 14%... = 64%

A similar calculation for chances of reaching 75% tile point yields chances of being in top ¼ of class...... .... = 30%

Therefore a student with a math science average of 60.5% is most likely to be at the 61% tile with respect to relative success to the end of Year C of the three year Electronics program at N.A.I.T., has a 2 in 3 chance of being between 32-85% tile points, has a 64% chance of being in the top half of the class and a 30% chance of being in the top quarter of the class.

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[7] *Ibid.*

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